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THE LAST WEST INDIAN TORNADO.

NEVER in the memory of the oldest inhabitants of the West Indies has so fierce a storm swept the islands as that which raged over the whole Gulf of Mexico some months ago. The tornado completely ruined the inhabitants of the Leeward Islands. With the exception of two municipal buildings, not a house was left standing in Plymouth. Solid walls two feet in thickness could not withstand the storm. Many who sought refuge in churches and schools lost their lives.

On the sea the winds were so furious that vessels were driven ashore. Our illustration, reproduced from the Illustrirte Welt, shows with what violence the storm must have raged along the coast.

The Journal of the Society of Chemical Industry describes the electrolytic extraction of quicksilver process. The raw material (cinnabar) is crushed to a fine powder, and then treated with a hot solution of sodium sulphide containing caustic soda. The electrolytic vats are of iron, and may be used as cathodes; the anodes are of sheet steel. It is stated that the mercury can be readily separated from the upper part of the cell, and is enriched with equivalent amounts of copper, silver, zinc, cadmium, nickel, and iron in the lower or anodic compartment of the cell. The solution on issuing from the cell is then passed through a series of vessels, in which the silver is displaced by copper by simple chemical action. Copper equal to about $\frac{1}{11}$ of the weight of the alloy used has to be consumed in these in order to effect the desired precipitation of the silver. It is not possible to remove the last traces of silver by this method, but the amount found in the deposited copper should not exceed 0·03 per cent. when the process is working satisfactorily. After passing through a series of the sulphide solution by using a current density of 0·5–0·8 ampere per square decimeter and an E.M.F. of 2 volts, the electrolyte can be used again for extracting fresh ore after addition of sulphur.

[Continued from SUPPLEMENT, No. 1243, page 19933.]

THE PROGRESS OF SCIENCE AND ITS RESULTS.*

By Prof. Sir MICHAEL FOSTER, K.C.B., Sec. R.S.

THE EFFECT OF INCREASING KNOWLEDGE ON MAN.

THE story of natural knowledge, of science, in the nineteenth century, as, indeed, in preceding centuries, is, I repeat, a story of continued progress. There is in it not so much as a hint of falling back, not even of standing still. What is gained by scientific inquiry is gained for ever; it may be added to, it may seem to be covered up, but it can never be taken away. Confident that the progress will go on, we cannot help peering into the years to come and straining our eyes to foresee what science will become and what it will do as they roll on. While we do so, the thought must come to us, Will all the increasing knowledge of Nature avail only to change the ways of man—will it have no effect on man himself?

The material good which mankind has gained and is gaining through the advance of science is so imposing as to be obvious to everyone, and the praises of this aspect of science are to be found in the mouths of all. Beyond all doubt science has greatly lessened and has markedly narrowed hardship and suffering; beyond all doubt science has largely increased and has widely diffused ease and comfort. The appliances of science have, as it were, covered with a soft cushion the rough places of life, and that not for the rich only, but also for the poor. So abundant and so prominent are the material benefits of science that in the eyes of many these seem to be the only benefits which she brings. She is often spoken of as if she were useful and nothing more, as if her work were only to administer to the material wants of man.

Is this so?

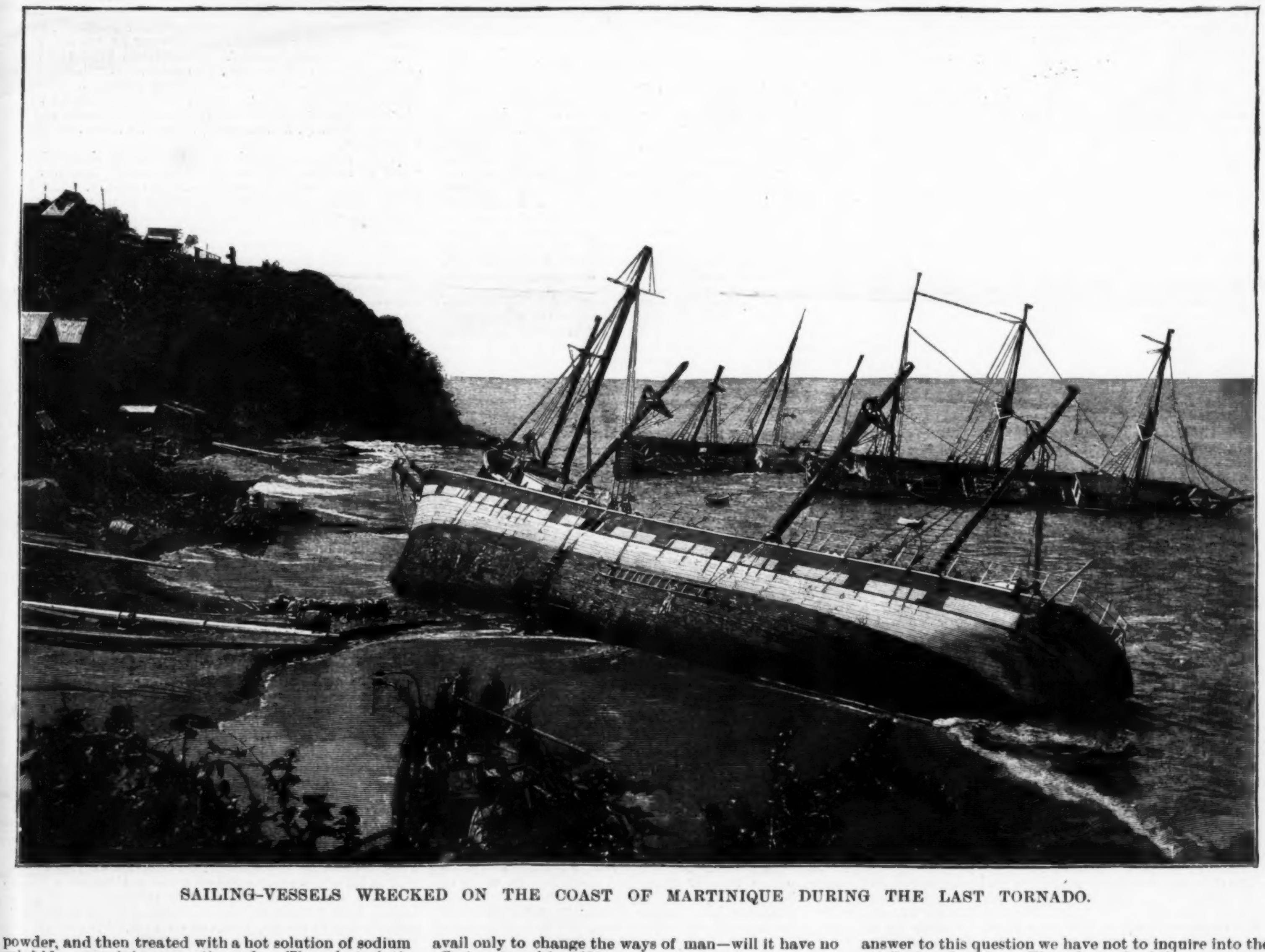
We may begin to doubt it when we reflect that the triumphs of science which bring these material advantages are in their very nature intellectual triumphs. The increasing benefits brought by science are the results of man's increasing mastery over Nature, and that mastery is increasingly a mastery of mind; it is an increasing power to use the forces of what we call inanimate nature in place of the force of his own or other creature's bodies; it is an increasing use of mind in place of muscle.

Is it to be thought that that which has brought the mind so greatly into play has had no effect on the mind itself? Is that part of the mind which works out scientific truths a mere slavish machine producing results it knows not how, having no part in the good which in its working it brings forth?

What are the qualities, the features, of that scientific mind which has wrought, and is working, such great changes in man's relation to Nature? In seeking an answer to this question we have not to inquire into the attributes of genius. Though much of the progress of science seems to take on the form of a series of great steps, each made by some great man, the distinction in science between the great discoverer and the humble worker is one of degree only, not of kind. As I was urging just now, the greatness of many great names in science is often, in large part, the greatness of occasion, not of absolute power. The qualities which guide one man to a small truth silently taking its place among its fellows, as these go to make up progress, are at bottom the same as those by which another man is led to something of which the whole world rings.

The features of the fruitful scientific mind are in the main three.

In the first place, above all other things, his nature must be one which vibrates in unison with that of which he is in search; the seeker after truth must himself be truthful, truthful with the truthfulness of Nature. For the truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more exacting. Man, unscien-



SAILING-VESSELS WRECKED ON THE COAST OF MARTINIQUE DURING THE LAST TORNADO.

* Presidential Address to the British Association for the Advancement of Science, delivered at Dover, on Wednesday, September 13, 1899.

tific man, is often content with "the nearly" and "the almost." Nature never is. It is not her way to call the same two things which differ, though the difference may be measured by less than the thousandth of a milligramme or of a millimeter, or by any other like standard of minuteness. And the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature's differences in any other way than she treats them herself, will find that she resents his conduct; if he in carelessness or in disdain overlooks the minute difference which she holds out to him as a signal to guide him in his search, the projecting tip, as it were, of some buried treasure, he is bound to go astray, and the more strenuously he struggles on, the farther will he find himself from his true goal.

In the second place, he must be alert of mind. Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint however small, to listen to her whisper however low.

In the third place, scientific inquiry, though it be pre-eminently an intellectual effort, has need of the moral quality of courage—not so much the courage which helps a man to face a sudden difficulty as the courage of steadfast endurance. Almost every inquiry, certainly every prolonged inquiry, sooner or later goes wrong. The path, at first so straight and clear, grows crooked and gets blocked; the hope and enthusiasm, or even the jaunty ease, with which the inquirer set out leave him, and he falls into a slough of despond. That is the critical moment calling for courage. Struggling through the slough, he will find on the other side the wicket-gate opening up the real path; losing heart, he will turn back and add one more stone to the great cairn of the unaccomplished.

But, I hear someone say, these qualities are not the peculiar attributes of the man of science; they may be recognized as belonging to almost everyone who has commanded or deserved success, whatever may have been his walk of life. That is so. That is exactly what I would desire to insist, that the men of science have no peculiar virtues, no special powers. They are ordinary men, their characters are common, even commonplace. Science, as Huxley said, is organized common sense, and men of science are common men, drilled in the ways of common sense.

For their life has this feature. Though in themselves they are no stronger, no better than other men, they possess a strength which, as I just now urged, is not their own, but is that of the science whose servants they are. Even in his apprenticeship, the scientific inquirer, while learning what has been done before his time, if he learns it aright, so learns it that what is known may serve him not only as a vantage ground whence to push off into the unknown, but also as a compass to guide him in his course. And when fitted for his work he enters on inquiry itself, what a zealous anxious guide, what a strict and, because strict, helpful schoolmistress does Nature make herself to him! Under her care every inquiry, whether it bring the inquirer to a happy issue or seem to end in nought, trains him for the next effort. She so orders her ways that each act of obedience to her makes the next act easier for him, and step by step she leads him on toward that perfect obedience which is complete mastery.

Indeed, when we reflect on the potency of the discipline of scientific inquiry, we cease to wonder at the progress of scientific knowledge. The results actually gained seem to fall so far short of what under such guidance might have been expected to have been gathered in that we are fain to conclude that science has called to follow her, for the most part, the poor in intellect and the wayward in spirit. Had she called to her service the many acute minds who have wasted their strength struggling in vain to solve hopeless problems, or who have turned their energies to things other than the increase of knowledge; had she called to her service the many just men who have walked straight without the need of a rod to guide them, how much greater than it has been would have been the progress of science, and how many false teachings would the world have been spared! To men of science themselves, when they consider their favored lot, the achievements of the past should serve not as a boast, but as a reproach.

If there be any truth in what I have been urging, that the pursuit of scientific inquiry is itself a training of special potency, giving strength to the feeble and keeping in the path those who are inclined to stray, it is obvious that the material gains of science, great as they may be, do not make up all the good which science brings or may bring to man. We especially, perhaps, in these later days, through the rapid development of the physical sciences, are too apt to dwell on the material gains alone. As a child in its infancy looks upon its mother only as a giver of good things, and does not learn till in after days how she was also showing her love by carefully training it in the way it should go, so we too have thought too much of the gifts of science, overlooking her power to guide.

Man does not live by bread alone, and science brings him more than bread. It is a great thing to make two blades of grass grow where before one alone grew; but it is no less great a thing to help a man to come to a just conclusion on the questions with which he has to deal. We may claim for science that while she is doing the one she may be so used as to do the other also. The dictum just quoted, that science is organized common sense, may be read as meaning that the common problems of life which common people have to solve are to be solved by the same methods by which the man of science solves his special problems. It follows that the training which does so much for him may be looked to as promising to do much for them. Such aid can come from science on two conditions only. In the first place, this her influence must be acknowledged; she must be duly recognized as a teacher no less than as a hewer of wood and a drawer of water. And the pursuit of science must be followed not by the professional few only, but, at least in such measure as will insure the influence of example, by the many. But this latter point I need not urge before this great Association, whose chief object during more than half a century has been to bring within the fold of science all who would answer to the call. In the second place, it must be understood that the training to be looked for from science is the outcome not of the accumulation of scientific knowledge, but of the practice of scientific inquiry. Man may have at his fingers' ends all the accomplished results and all the current opinions of any one or of all the branches of science, and yet remain wholly unscientific in mind; but no one can have carried out even the humblest research without the spirit of science in some measure resting upon him. And that spirit may in part be caught even without entering upon an actual investigation in search of a new truth. The learner may be led to old truths, even the oldest, in more ways than one. He may be brought abruptly to a truth in its finished form, coming straight to it like a thief climbing over the wall; and the hurry and press of modern life tempt many to adopt this quicker way. Or he may be more slowly guided along the path by which the truth was reached by him who first laid hold of it. It is by this latter way of learning the truth, and by this alone, that the learner may hope to catch something at least of the spirit of the scientific inquirer.

This is not the place, nor have I the wish, to plunge into the turmoil of controversy; but if there be any truth in what I have been urging, then they are wrong who think that in the schooling of the young science can be used with profit only to train those for whom science will be the means of earning their bread. It may be that from the point of view of the pedagogic art the experience of generations has fashioned out of the older studies of literature an instrument of discipline of unusual power, and that the teaching of science is as yet but a rough tool in unpracticed hands. That, however, is not an adequate reason why scope should not be given for science to show the value which we claim for it as an intellectual training fitted for all sorts and conditions of men. Nor need the studies of humanity and literature fear her presence in the schools, for if her friends maintain that that teaching is one sided, and therefore misleading, which deals with the doings of man only, and is silent about the works of Nature, in the sight of which he and his doings shrink almost to nothing, she herself would be the first to admit that that teaching is equally wrong which deals only with the works of Nature and says nothing about the doings of man, who is, to us at least, Nature's center.

SCIENCE WORKS FOR GOOD.

There is yet another general aspect of science on which I crave leave to say a word. In that broad field of human life which we call politics, in the struggle not of man with man, but of race with race, science works for good. If we look only on the surface, it may at first sight seem otherwise. In no branch of science has there during these later years been greater activity and more rapid progress than in that which furnishes the means by which man brings death, suffering and disaster on his fellow men. If the healer can look with pride on the increased power which science has given him to alleviate human suffering and ward off the miseries of disease, the destroyer can look with still greater pride on the power which science has given him to sweep away lives and to work desolation and ruin; while the one has slowly been learning to save units, the other has quickly learned to slay thousands. But, happily, the very greatness of the modern power of destruction is already becoming a bar to its use, and bids fair—may we hope before long—wholly to put an end to it. In the words of Tacitus, though in another sense, the very preparations for war, through the character which science gives them, make for peace.

Moreover, not in one branch of science only, but in all, there is a deep undercurrent of influence sapping the very foundations of all war. As I have already urged, no feature of scientific inquiry is more marked than the dependence of each step forward on other steps which have been made before. The man of science cannot sit by himself in his own cave weaving out results by his own efforts, unaided by others, heedless of what others have done and are doing. He is but a bit of a great system, a joint in a great machine, and he can only work aright when he is in due touch with his fellow workers. If his labor is to be what it ought to be, and is to have the weight which it ought to have, he must know what is being done, not by himself, but by others, and by others not of his own land, and speaking his tongue only, but also of other lands and of other speech. Hence it comes about that to the man of science the barriers of manners and of speech which pen men into nations become more and more unreal and indistinct. He recognizes his fellow worker, wherever he may live and whatever tongue he may speak, as one who is pushing forward shoulder to shoulder with him toward a common goal, as one whom he is helping and who is helping him. The touch of science makes the whole world kin.

The history of the past gives us many examples of this brotherhood of science. In the revival of learning throughout the sixteenth and seventeenth centuries, and some way on into the eighteenth century, the common use of the Latin tongue made intercourse easy. In some respects in those earlier days science was more cosmopolitan than it afterward became. In spite of the difficulties and hardships of travel, the men of science of different lands again and again met each other face to face, heard with their ears, and saw with their eyes what their brethren had to say or show. The Englishman took the long journey to Italy to study there; the Italian, the Frenchman, and the German wandered from one seat of learning to another, and many a man held a chair in a country not his own. There was help, too, as well as intercourse. The Royal Society of London took upon itself the task of publishing nearly all the works of the great Italian Malpighi, and the brilliant Lavoisier, two years before his own countrymen in their blind fury slew him, received from the same body the highest token which it could give of its esteem.

In these closing years of the nineteenth century this great need of mutual knowledge and of common action felt by men of science of different lands is being manifested in a special way. Though nowadays what is done anywhere is soon known everywhere, the news of a discovery being often flashed over the globe by telegraph, there is an increasing activity in the direction of organization to promote international meetings and international co-operation. In almost every science inquirers from many lands now gather together at stated intervals in international congresses to discuss matters which they have in common at heart, and go away each one feeling strengthened by having met his brother. The desire that in the struggle to lay bare the secrets of Nature the least waste of human energy should be incurred is leading more and more to the concerted action of nations combining to attack problems the solution of which is difficult and costly. The determination of standards of measurement, magnetic surveys, the solution of great geodetic problems, the mapping of the heavens and of the earth—all these are being carried on by international organizations.

In this and in other countries men's minds have this long while past been greatly moved by the desire to make fresh efforts to pierce the dark secrets of the forbidding Antarctic regions. Belgium has just made a brave single-handed attempt; a private enterprise sailing from these shores is struggling there now, lost for the present to our view; and this year we in England and our brethren in Germany are, thanks to the promised aid of the respective governments, and no less to private liberality, in which this association takes its share, able to begin the preparation of carefully organized expeditions. That international amity of which I am speaking is illustrated by the fact that in this country and in that there is not only a great desire, but a firm purpose, to secure the fullest co-operation between the expeditions which will leave the two shores. If in this momentous attempt any rivalry be shown between the two nations, it will be for each a rivalry, not in forestalling, but in assisting the other. May I add that if the story of the past may seem to give our nation some claim to the seas as more peculiarly our own, that claim bespeaks a duty likewise peculiarly our own to leave no effort untried by which we may plumb the seas' yet unknown depths and trace their yet unknown shores? That claim, if it means anything, means that when nations are joining hands in the dangerous work of exploring the unknown South, the larger burden of the task shall fall to Britain's share; it means that we in this country should see to it, and see to it at once, that the concerted Antarctic expedition which in some two years or so will leave the shores of Germany, of England, and, perhaps, of other lands, should, so far as we are concerned, be so equipped and so sustained that the risk of failure and disaster may be made as small, and the hope of being able not merely to snatch a hurried glimpse of lands not yet seen, but to gather in with full hands a rich harvest of the facts which men not of one science only, but of many, long to know, as great as possible.

Another international scientific effort demands a word of notice. The need which every inquirer in science feels to know, and to know quickly, what his fellow worker, wherever on the globe he may be carrying on his work or making known his results, has done or is doing, led some four years back to a proposal for carrying out by international co-operation a complete current index, issued promptly, of the scientific literature of the world. Though much labor in many hands has been spent upon the undertaking, the project is not yet an accomplished fact. Nor can this, perhaps, be wondered at when the difficulties of the task are weighed. Difficulties of language, difficulties of driving in one team all the several sciences which, like young horses, wish each to have its head free with leave to go its own way, difficulties mechanical and financial of press and post, difficulties raised by existing interests—these and yet other difficulties are obstacles not easy to be overcome. The most striking and the most encouraging features of the deliberations which have now been going on for three years have been the repeated expressions, coming not from this or that quarter only, but from almost all quarters, of an earnest desire that the effort should succeed, of a sincere belief in the good of international co-operation and of a willingness to sink as far as possible individual interests for the sake of the common cause. In the face of such a spirit we may surely hope that the many difficulties will ultimately pass out of sight.

Perhaps, however, not the least notable fact of international co-operation in science is the proposal which has been made within the last two years that the leading academies of the world should, by representatives, meet at intervals to discuss questions in which the learned of all lands are interested. A month hence a preliminary meeting of this kind will be held at Wiesbaden; and it is at least probable that the closing year of that nineteenth century in which science has played so great a part may at Paris during the great World's Fair—which every friend, not of science only, but of humanity, trusts may not be put aside or even injured through any untoward event, and which promises to be an occasion not of pleasurable sight-seeing only, but also, by its many international congresses, of international communing in the search for truth—witness the first select Witenagemote of the science of the world.

I make no apology for having thus touched on international co-operation. I should have been wanting, had I not done so, to the memorable occasion of this meeting. A hundred years ago two great nations were grappling with each other in a fierce struggle, which had lasted, with pauses, for many years, and was to last for many years to come; war was on every lip and in almost every heart. To-day this meeting has, by a common wish, been so arranged that those two nations should, in the persons of their men of science, draw as near together as they can, with nothing but the narrow streak of the Channel between them, in order that they may take counsel together on matters in which they have one interest and a common hope. May we not look upon this brotherly meeting as one of many signs that science, though she works in a silent manner and in ways unseen by many, is steadily making for peace?

MUCH TO GIVE HOPE.

Looking back, then, in this last year of the eighteen hundreds, on the century which is drawing to its close, while we may see in the history of scientific inquiry much which, telling the man of science of his shortcomings and his weakness, bids him be humble, we also see much, perhaps more, which gives him hope. Hope is, indeed, one of the watchwords of science. In the latter-day writings of some who know not science, much may be read which shows that the writer is losing or has

lost hope in the future of mankind. There are not a few of these; their repeated utterances make a sign of the times. Seeing in matters lying outside science few marks of progress and many tokens of decline or of decay, recognizing in science its material benefits only, such men have thoughts of despair when they look forward to the time to come. But if there be any truth in what I have attempted to urge to-night, if the intellectual, if the moral influences of science are no less marked than her material benefits, if, moreover, that which she has done is but the earnest of that which she shall do, such men may pluck up courage and gather strength by laying hold of her garment. We men of science at least need not share their views or their fears. Our feet are set, not on the shifting sands of the opinions and of the fancies of the day, but on a solid foundation of verified truth, which by the labors of each succeeding age is made broader and more firm. To us the past is a thing to look back upon, not with regret, not as something which has been lost never to be regained, but with content, as something whose influence is with us still, helping us on our further way. With us, indeed, the past points not to itself, but to the future; the golden age is in front of us, not behind us; that which we do know is a lamp whose brightest beams are shed into the unknown before us, showing us how much there is in front, and lighting up the way to reach it. We are confident in the advance, because, as each one of us feels that any step forward which he may make is not ordered by himself alone and is not the result of his own sole efforts in the present, but is, and that in large measure, the outcome of the labors of others in the past, so each one of us has the sure and certain hope that as the past has helped him, so his efforts, be they great or be they small, will be a help to those to come.

UNWATERING THE COMSTOCK LODE.

By L. P. GRATACAP.

AN operation of immense interest to miners and mining generally has been in progress for the past five months in Nevada, in the district embracing the well-known Comstock mines. The remarkable circumstances connected with the discovery and development of the wonderful lode upon which these famous mines are located is a matter of comparatively recent history —too recent to require more than a passing reference. The wild speculation which followed their discovery forms one of the most thrilling pages of the annals of the Far West. It is estimated that up to the year 1886 the assay value of the gold and silver extracted from these mines amounted to $500,000,000. It was during this period of greatest production that the race of California multi-millionaires arose. Up to 1886 the exploration of all the territory embraced in the Comstock lode was industriously pursued, one shaft reaching a depth of 3,300 feet, but the exhaustion of ore bodies of high grade and the large expense attending milling and mining together with the heavy tax necessary in controlling the enormous volumes of water which everywhere flowed from the ground caused an abandonment of all mining below the 1,600-foot level. Another element of difficulty was the high temperatures experienced on the deeper levels, which increased as the shafts were lowered until miners were able only to work in shifts of a few moments in length.

In a few months the water arose to within 1,640 feet of the surface opening of the Consolidated California and Virginia shaft, and at that level it has remained for nearly thirteen years. Above this level mining has been prosecuted with some success since the lower levels were flooded, and it is now believed that all pay ore bodies above the 1,600-foot level are practically exhausted.

The contingency then arose whether to cease all mining in the territory or else to expel the water from the lower levels and resume.

It is known to all engineers who have ever experted the Comstock mines that in the lower territory there exist unknown amounts of ore running from $16 to $20 a ton, and to even higher value.

It is also believed that in the large extent of territory that has never been explored at all, rich blocks of ore may yet be found. The facts are that the expense of mining and milling has been so greatly reduced that ores running even below $4 a ton can be made to yield a fair profit, and furthermore, that pumping, which once cost at the rate of fifty cents for every 1,000 gallons, can now be done for less than one-twelfth of that.

The mines affected by an ultimate decision included the Utah, Sierra Nevada, Union, Mexican, Ophir, Consolidated California and Virginia, Best and Belcher, Gould and Curry, Savage, Hale and Norcross, Chollar, Potosi, Yellow Jacket, Kentuck, Crown Point, Belcher, Overman, Caledonia, Alta and Justice, all, at some time, heavy producers with shafts from 2,600 to 3,300 feet in depth. Invention has settled the difficulty of ventilating the lowest levels, and the practicability of pumping even greater quantities of water than exist in the Comstock and at lower depths than 3,200 feet has been conclusively demonstrated.

The substitution of electric power for steam is in contemplation as soon as the mines are emptied. Within a radius of forty miles from the Comstock there are streams which will afford all the electric power that these mines can ever employ. The work of pumping, ventilating, mining, lighting and transporting can be done by power cheaply generated, and in every department this power can be applied and the cost of extraction and milling reduced to a figure which would make the handling of existing great bodies of cheap ores a profitable undertaking.

The faith of the stockholders in the future of the mines of the Comstock lode has never been entirely quenched, and but for untoward conditions in the financial world, for some years past, the attempt to reopen the lower levels would have long since been made. The opportune moment has been anxiously awaited.

The first movement for the rehabilitation of the Comstock mines began in the latter part of 1898, when a meeting of the directors of the companies interested was called to consider the subject. It was decided to proceed and to raise by assessments on stock or by appropriation from existing resources, $100,000 with which to drain the mines down to a point 500 feet below their permanent level, which was 40 feet below the mouth of the Sutro tunnel.

Bids for a mechanical plant to accomplish this result were advertised for, and many makers of pumps submitted propositions. A plan by which the water level could be reduced 500 feet was presented to cost $30,000, payment conditional upon the success attained. The proposition was so far below the sum which the directors expected that a contract was at once entered into between the parties. The method proposed was an adaptation of the hydraulic elevator, a system in common use in the mines of California.

The undertaking involved the lowering of the water level in the Consolidated California and Virginia, 500 feet, by which the entire territory above that level would be drained. The plant required was a standpipe extending from the surface to the required depth, terminating in a contracted throat which discharged into the flaring mouth of an elevator pipe having its outlet in the Sutro tunnel.

The force elevating the water is due to the pressure and velocity of the jet carrying a continuous flow to the point where it is discharged.

The adoption of this system, one well known to all hydraulic engineers, has never before been employed in a task of the magnitude presented at the Comstock mines. In a certain sense it was an experiment, but the contractors never for a moment doubted the success of the attempt, and so far their anticipations seem to have been well founded.

The elevation of the consolidated shaft at the surface is 6,105 feet above the sea. Its extreme depth is 2,900 feet. Its dimensions are 6 × 8 feet and it is, of course, timbered throughout. The water for supplying the elevator is ample in quantity and close at hand, obtained from a ditch which furnishes Virginia City its water supply and extends from the headwaters of Carson River, 28 miles distant. The capacity of the ditch is from 150 to 300 miners' inches (of 1½ cubic feet each) per minute. A clause of the contract limited the space in the shaft to be occupied to 2 × 3 feet.

Soon after the contract was let work was begun, and by January 26 (90 days after signing contract) the apparatus and material were on the ground. It consisted of 12-inch steel pipe for the flow and sufficient 15-inch pipe for the discharge.

At a depth of 1,740 feet below the surface, the first station was reached. This was 100 feet below the water level and here the first pumping was done. The pressure at the jet was 1,136 pounds per square inch, and the flow from the surface 1,100 gallons a minute. With the first attempt 8,000 gallons per minute was discharged into the Sutro tunnel, 140 feet above the jet. This was on February 20. Great precaution was observed in bracing the pipes to the sides of the shaft as well as in testing the quality of the steel used in fabricating them. The disastrous consequences to life and property of a fracture under the heavy pressure employed necessitated the most complete vigilance.

All the material being on the ground, installation of the pipes was begun on February 1, and on the 17th of the same month was completed and the connections made with the supply ditch.

A preliminary experiment at one-third pressure with the supply pipes only partially filled indicated a pressure at the jet of 300 pounds. With this force 6,000 gallons a minute was raised to the Sutro tunnel with a strength which threw the stream four feet from the outlet of the pipe and lowering the water in the shaft 45 feet in two hours. The first experiment demonstrated the success of the plan. Some interruptions ensued for the next few days, caused by the necessity of strengthening pipe connections, but on February 20 measurement showed a reduction in the water level of 100 feet. An investigation of all the shafts in the territory adjacent showed a reduction of the water level greater or less according to the condition of connecting shafts. In some instances communications were obstructed by caves and the accumulation of slime. Evidences of flow from the most distant levels were clearly demonstrated. The water was lowered with deliberation, the elevator was at times closed in order to anticipate any danger of rushes of water by sudden giving away of obstructions formed in communicating shifts, during the years in which the territory has been submerged. With the removal of water in the shaft a new connection, generally about 50 feet, was added to both pipes.

Some changes and modifications were found necessary as the depth and pressure on the pipes increased. Imperfections in the material developed as the work progressed, but these were promptly rectified. The jet section of the pipe, first of steel, was replaced by one of phosphor bronze, which gave added strength and more liberal clearance.

A duplicate elevator was subsequently installed, allowing repairs to each, when required, without interruption of the work.

In the present month the pumping was facilitated by the introduction into the elevator pipes of a small volume of compressed air. The effect of this was to reduce friction in the pipe and also vibration.

On April 5, the nozzle of the supply pipe was enlarged and measurement showed a discharge of 150 miners' inches of water, and elevating 7,000 gallons a minute. With both elevators at work, the discharge was 8,400 gallons a minute. The supply pipe at the surface taking in 2,000 gallons per minute. The cost of the water from the ditch has proved to be less than $4 a day.

Report of operations Comstock Pumping Association for the week ending July 7, 1899:

"The No. 1 elevator has been continuously at work since the last weekly report. Between the 6th and the 7th of the present month there was a rise of water in the shaft, the water standing between 3 and 5 feet deep in the 1,950 station. This station is connected with a network of drifts, and the ebbing and flowing of the water is evidently due to some slight obstructions in these drifts that give way under the pressure of water back of them. The variation in the discharge of the elevator has been very slight. It is now discharging more water than when started and nearly, if not fully, as much as at any time since starting. The water is steadily draining into the C. C. and V. shaft from the surrounding country and it is but reasonable to expect that the No. 1 elevator will very shortly drain the 1950 level. G. McM. ROSS, Supt."

As the water has gradually lowered, access to the submerged territory is made practicable. It is found that the conditions after twelve years had not affected the shaft disastrously and preparations for thoroughly prospecting the ground and for taking out bodies of ore that are known to have existed when the lower workings were abandoned, have already commenced.

It is not intended to operate the present system below the 2,100-foot level. At that depth, if it is decided to open the lower parts of the mines, a permanent pumping plant driven by electricity will be installed. By the same power it is expected that the problem of ventilating will be solved. The theory of geologists, that the Comstock lode extends obliquely to an indefinite depth, will be demonstrated should the contemplated operations prove successful.

ELECTRICAL MACHINERY ON BOARD SHIP.*

EVERYBODY is familiar with the great advance in comfort on board ship following the substitution of electric lights for candle and oil lights, and it is only natural that ever since the first application of electricity, endeavors should have been made to extend its use on board ship.

The first part of the electrical system to be developed was the generating plant, as it was very soon apparent that belt-driving, otherwise universally resorted to, was not reliable enough. As a first improvement, Mr. J. S. Raworth constructed rope pulleys for an endless rope, which could be stretched while running by means of a movable guide pulley. This rope gear, although it avoided the danger due to the belt slipping off the pulleys, shared with the belt-driving the serious disadvantage of occupying too much space.

About the same time, Brotherhood engines, running at a high speed, were first used coupled direct to dynamos; but their construction at that time was not very well understood, and the ships' engineers greatly preferred double-acting engines of simple construction. To meet their views, and to economize space, Mr. Haworth constructed a friction driving gear, which has been extensively used, and merits, therefore, a short description. The dynamo is bolted to a cradle which can rock the dynamo in the direction of the armature spindle, and this carries a pulley of compressed paper, which is driven by the flywheel of the steam engine, against which it is pressed by adjustable springs. The cradle supporting the dynamo is placed between the steam engine and the flywheel, so that the whole arrangement is very compact.

After this gear had been in use for some time, Mr. Charles Hall, the electrical engineer of the P. and O. Company, suggested driving the dynamo direct by a Tangye engine at the comparatively low speed of 180 to 200 revolutions per minute.

This type of generating plant has practically been adopted for all modern ships, and it may be observed in passing that direct driving is nowadays recognized, even in places where there is no want of space, as superior to belt-driving for all purposes.

In view of the contention that English practice is lagging behind that of other countries, it is as well to remember that at the Chicago Exhibition the two or three direct-driven sets were almost ridiculed by the American engineers, who confidently predicted that the Old Country would soon drop this practice and adopt the American method of belt-driving.

As a plant typical of the American practice of that time, the power plant of the Brooklyn tramways can be mentioned, where Corliss compound engines drove a flywheel, from which a belt, five feet wide, drives two dynamos on the first floor of the building.

It is needless to say that direct driving is now as much in use in the United States as it is here, and, in fact, everywhere. There can, therefore, be little doubt that the type of generating plant adopted on board ship has reached a stage in its development which, no doubt, will be improved, but will not be materially altered.

When electricity was introduced on board Her Majesty's ships some inconvenience was caused by the magnetic field of the dynamos affecting the ships' compasses in cases where iron bulkheads happened to be near the dynamos, and extended to the neighborhood of the compasses. In order to guard against eventualities of that kind, it is now usual to employ iron-clad dynamos on the men-of-war. For the same purpose, the distribution of the electricity is in most cases effected by the double wire system, the flow and return being laid side by side to all points of utilization. These conductors form the most valuable part of the electric system, through being easily adapted to the scanty accommodation on board, readily repaired, without danger arising from their being damaged, when they are properly fitted up and easily tested to ascertain that they are in working condition.

Such qualities contributed not a little to the speedy introduction of the electric light, but they are still more appreciated for the distribution of power. The larger the ships are the more it becomes necessary to supplement manual labor by mechanical power, and it is a trite saying that modern ships are nothing but machine shops.

Until lately it was usual to drive all this auxiliary machinery by small steam engines or by hydraulic power, and this necessitated a network of piping all over the ship, which is difficult to arrange neatly, and which gives endless trouble through leakage. In addition, there are waste products from all the auxiliary steam engines, and their disposal requires additional pipes and complications. All this inconvenience is avoided by employing electric motors, and for certain purposes, where the load on the motor does not vary much, they have been generally introduced.

That their use has not been more extended is due to the difficulties which arise from variations in the load on the auxiliary machinery. Taking the case of a winch, it frequently happens that the strain on a cable increases sufficiently to stop the movement of the winch altogether, and this would cause the current through the electric motor to rise to a dangerous extent. It is impracticable to protect the motor by a fuse, as the interruption of the circuit through the blowing of the fuses would allow the strain being taken off the winch, and in most nautical operations it is necessary to keep the strain on.

There are two methods in use to overcome this diffi-

* Abstract of paper by Alexander Siemens, M.Inst.C.E., read before the British Association meeting at Dover.

culty; one is to employ shunt-wound motors, running continuously, and operating the winches, etc., through friction clutches; and the second is to employ special cut-outs in connection with series-wound motors. By these cut-outs the current through the motors is not interrupted altogether, but if the winch or other machinery is stopped so that the current becomes excessive, the main circuit is interrupted and a by-pass only left, in which sufficient resistance is inserted to allow only the maximum safe current to pass.

As an example of the first method, a steering gear and rudder indicator may be mentioned, which are constructed on similar lines, the indicator being, so to speak, a working model of the steering gear. A shunt-wound electric motor replaces the usual steam engine and turns the main shaft of the steering gear backward and forward by means of clutches, which are actuated by currents sent from the bridge. The current through the magnets actuating the clutches is interrupted automatically by the movement of the rudder-head, and a new impulse is wanted from the bridge before the steering gear will move again.

For the convenience of the quartermaster, the contact-making apparatus on the bridge is designed in the usual shape of a small steering wheel, so that it does not differ externally from the wheel used with steam-steering apparatus. On the rudder-head a similar contact apparatus is fixed, which controls the solenoid clutches of the rudder indicator on the bridge, which is, as stated above, a working model of the steering gear, and shows the quartermaster the exact position of the rudder-head.

Such an indicator has been in use on the steamship "Faraday" for some time, and has given complete satisfaction, so that it is contemplated to substitute the corresponding electric steering gear for the present steam steering gear as soon as room can be found for larger generating plant.

Here, again, appears an obstacle to the introduction of electric motors on board, and it can only be overcome by designing the engine rooms for the accommodation of powerful electric generating plant.

There is every indication that this requirement is now being fully recognized, and that in future it will be possible to utilize electric motors in connection with all auxiliary machinery, and the absence of all pipework outside the engine room and boiler space will greatly increase the safety and convenience of working ships.

Sometimes it has been suggested that the main engines of a transatlantic liner should also be worked by electricity, either on the plan adopted by Mr. Heilmann for locomotives, or by means of accumulators. Although this may seem feasible at first sight, our present knowledge is not sufficiently advanced to make a practical test of either suggestion. Marine engines are the lightest per horse power that are constructed; it would, therefore, not be possible to put smaller engines on board to generate electricity than those now used to drive the propellers direct. It is, therefore, self-evident that the Heilmann system cannot be economically applied for the main engines of ships.

Equally impossible would it be to use accumulators for driving electric motors connected to the propeller shafts, as their weight would greatly exceed the capacity of the ship. This is easily shown by the consideration that a 6,000-ton ship, propelled by 8,000 indicated horse power, will take about 150 hours to cross the ocean, equal to 1,200,000 horse power hours. Fairly efficient accumulators give about 10 watt hours per 1 pound of their weight, so that a horse power hour can be obtained for 75 pounds of accumulators. The ship in question would, therefore, have to load about 40,000 tons of accumulators for the trip across the Atlantic.

No doubt there are further discoveries in store which will enable future electricians to attack the problem of propelling large ships electrically for long distances; for the present, it has only been proved to be an advantage to drive electrically the auxiliary machinery on board ship.

MECHANICAL PERPETUAL CALENDAR.

THE perpetual calendar which we are about to describe is the work of a Frenchman, M. Albert Jagot, of Mans, and was constructed by him during his leisure hours. It consists of but five wheels having a total of ninety-six teeth, and of nine levers or catches. It indicates automatically, without any attention save winding, the day of the week, the date, and the month; and shows the 29th of February every four years besides suppressing it in the centenary years that are not leap years and showing it in those that are.

Fig. 1 gives a general view of the calendar, Fig. 2 shows the interior mechanism, and Fig. 3 furnishes a complete diagram of the whole apparatus. A driving wheel, *A*, transmits motion to the day wheel, *D*; then the movement is further transmitted to a wheel bearing the dates, *W*, a cam wheel on which are the months, *T*, a wheel, *M*, which turns once in four years, and finally to a wheel, *V*. The weight, 1, is wound up twice a month, the weight 2 acts as a counter-weight, and the weight 3 needs winding annually.

We shall now describe the mechanical parts and indicate their several functions, using for this purpose the diagram, Fig. 3.

The wheel, *A*, is moved by a spring, and makes a revolution once in twenty-four hours. It has two peg teeth, *B B'*, on its circumference, the latter of which raises the catch, *C'*, at midnight, thus allowing the day wheel, *D*, to make one-seventh of a revolution. At two o'clock in the morning the catch, *C*, is raised by the tooth, *B*, and the latch, *C'*, falls back into place.

The date wheel, *W*, is advanced one tooth by this movement of the wheel, *D*. Mounted on it is a lever, *H*, which is pivoted to it, and which supports a bar, *J*, arranged to slide between two guides and to press against one of the projections, *K*, for example, of the cam wheel on which are stamped the months. This wheel has twelve cams which project at unequal distances from the center according to whether the month has 28, 30 or 31 days. When the bar, *J*, presses against one of the cams of *T*, the lever, *H*, acts on the arc piece, *I*. The movement is transmitted by *P* to the lever, *Q*, which engages the teeth of the wheel, *W*. *R* is a latch which holds *Q* at the point, *q*. A peg, *G*, is placed on the back of the wheel, *W*. The moment this wheel is disengaged from *Q*, it revolves backward and the peg raises the piece, *S'*, which releases the ratchet, *T*, and allows the month cam-wheel to make one-twelfth of a turn. The wheel, *W*, has then come around again to the first of the month, a tooth of the ratchet has struck the latch, *R*, at *r*, and the lever, *Q*, is again thrown into engagement with *W*.

The wheel, *M*, has eight teeth and makes a revolution every four years. It is moved by two points, *L L'*, on the cam wheel, *T*. *N* is an arm with a wedge-shaped piece, *N'*, fastened to its side. This arm projects vertically downward from the bottom of the wheel on February 1 of every leap year. A roller, *T*, mounted on the front of the wheel, *T*, and indicated in the diagram by a dot just above the letter, *T*, passes against the wedge, *N*, thus producing a slight movement of the cam backward along its shaft. *O* is the projecting face of the cam wheel, *T*, against which the bar, *J*, presses on February 28. It has a shelf, *O'*, near its end against which *J* presses on February 29, when the wheel, *W*, is pushed slightly back on its shaft by the wedge, *N'*.

U is a tooth of the wheel, *M*, that moves the large wheel, *V*, once every four years. This wheel has twenty-five teeth and makes a revolution once in a hundred years. The angle lever, $z\,\beta\,Z$, carries an arc, *z*, having a wedge-shaped face. This arc operates upon the shaft of *M*, which has a side movement back and forth. The wheel, *X*, carrying four arms is placed on the back of *V*, and is fastened to the same shaft as the three-armed wheel, *Y*, on the front of *V*. The point, π, is fixed to the framework and engages an arm of *X* at each revolution of *V*, thus causing *X* and *Y* to make one-fourth of a revolution. *Z* is a counterweight which keeps the arc, *z*, pressed against the shaft of *M*. It is raised during three successive hundred years by each of the three arms of *Y*; the thin edge of the wedge is pressed against the end of the shaft of *M*, which is then in its outer or front position, and it then allows the wheel, *M*, to move forward again and press against the other end of *z*. The wedge, *N'*, then passes without action before the roller, and February 28 is shown for three successive century years that are not leap years.

When the fourth century year arrives, which is a leap year, the wheel, *Y*, does not present an arm to engage the lever, *Z*, and the weight on the end of *Z* causes the thick end of the wedge, *z*, to be pressed against the shaft of *M*, which is thus moved backward sufficiently for *N'* to engage in the roller, *T*, and cause February 29 to be shown.

The weight, 1, is wound up every fifteen days, and the weight, 2, returns the wheel, *W*, to the first of the month.

Under the base are two pulleys with drums of small diameter on the same shaft. The cords of the weights, 1 and 3, are wound around the drums, while the cords from the wheels, *D* and *T*, make a turn around the pulleys. This arrangement lessens the drop of the weights.

The above simple description shows what an amount of work and ingenuity were put into the construction of this calendar. We believed it interesting to describe to our readers as a curiosity, indicating in a simple manner the working parts.—La Nature.

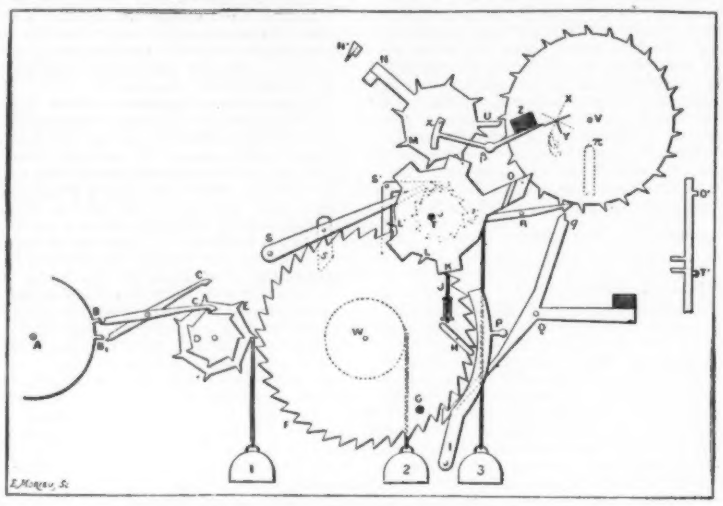


FIG. 3.—COMPLETE SCHEME OF MECHANISM.

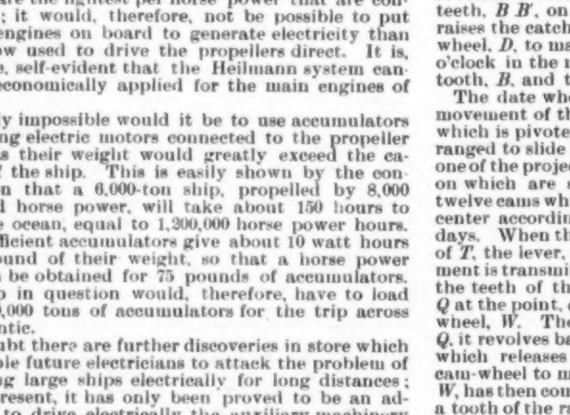


FIG. 1.—PERPETUAL CALENDAR—GENERAL VIEW.

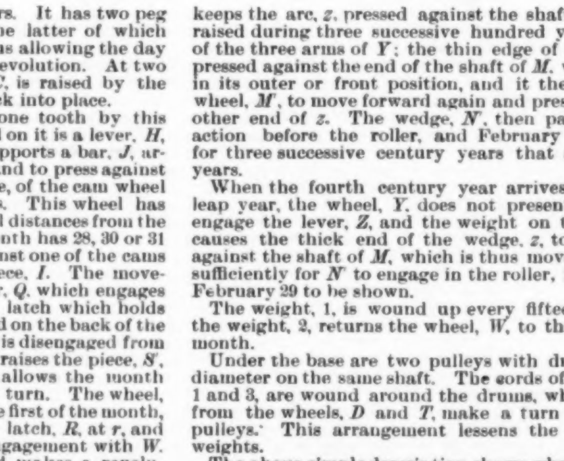


FIG. 2.—PERPETUAL CALENDAR—INTERIOR VIEW.

MACHINE FOR NOTCHING OUT THE ENDS OF GIRDERS.

WE illustrate a powerful double milling machine, specially designed for milling or notching out the ends of girders to fit in between the flanges of cross girders. It will operate on girders from 20 inches deep down to 12 inches, with both cutters. A single head only can be used when required.

The machine consists of a substantial bed on which are two vertical slides, one being a fixture and the other having an adjustment by screw and hand wheel to suit various depths of girders to be notched out. On each of these vertical slides traverses a carriage, carrying a steel spindle with a conical neck, on the end of which is the milling cutter specially designed for this operation. Each carriage has a self-acting feed, and quick return motion, controlled by a tappet and lever; there is also a vertical hand adjustment worked from the end of the shaft. The spindles are driven by a train of strong steel gearing, and compound spur gearing and pulleys at the end of the bed. The girders are cramped down on suitable blocks on the work table, which has a top slide adjustment by screw and gearing; this enables the girders to be adjusted accurately to the milling cutters. The cutters are kept cool and lubricated by a centrifugal circulating pump, and the necessary piping from the pump to the cutters. This machine, according to London Engineer, was constructed by Messrs. Isaac Hill & Son, Derby.

THE IMPROVED GOUBET SUBMARINE TORPEDO BOAT.

OF the many men who have endeavored to invent a practicable submarine boat, says Stein der Weisen, the French engineer, Goubet, seems to have been most successful in solving the problem of keeping the submerged vessel in equilibrium.

The apparatus by which this is accomplished is automatic in its operation, and is constructed on the principle of the balance. As the boat inclines from an even keel a double-acting pump is made to discharge water from a reservoir in the stern to another reservoir in the bow, or vice versa. The receptacles hence resemble the hands of a balance, and the weights represented by the water are shifted from one pan to another. The pumping of the water from one tank to the other is effected so rapidly that the vessel is almost immediately returned to an even keel.

The length of the boat is 8 meters (26·24 feet). The motive power is derived from accumulator batteries of sufficient capacity to drive the boat for fourteen hours. Enough compressed air is carried to supply the crew of two men with fresh air for eight hours. The screw of the boat is so arranged that it can be adjusted to all sides. The usual rudder is hence dispensed with. The boat by reason of its adjustable screw can be directed not only to the right or to the left but upward or downward. At the stern of the boat a torpedo tube is mounted by means of which a torpedo can be discharged upwardly against the bottom of a vessel where it is exploded electrically from the boat. The vessel is also provided at its nose with a device by means of which the cables of harbor mines can be cut. The light necessary for this operation is provided by an electric light mounted in the nose.

This boat is known as the "Goubet I." The inventor has, however, made various improvements which he has embodied in a new vessel called the "Goubet II." In the later boat access is had to the interior by means of a ladder which is removed before the dome is closed. The cover for the dome is rendered watertight by a rubber packing. In the "Goubet I." there was so little room that the two men who composed the crew were compelled to sit back to back in the center of the boat; the "Goubet II." is much roomier. The commander takes his position amidships in a revolving chair, so that he can see in every direction through the dome. His two assistants have charge of certain apparatus and are stationed at the ends of the boat with their faces turned to the center. The man at the bow manipulates two levers by means of which the valves of the water ballast are controlled. Behind his head is a tube in which a receptacle inclosing messages is placed; the vessel having a specific gravity less than that of water will rise to the surface to be received by friends above.

FIG. 1.—BOW OF THE "GOUBET II."

The electric motor is located in the stern and is driven by batteries placed beneath the deck timbers. Above the motor is a hand-wheel by means of which the screw propeller can be moved to any position. The tubes are located at each side of the vessel. An apparatus is also provided for releasing the leaden keel in order to enable the boat to rise rapidly.

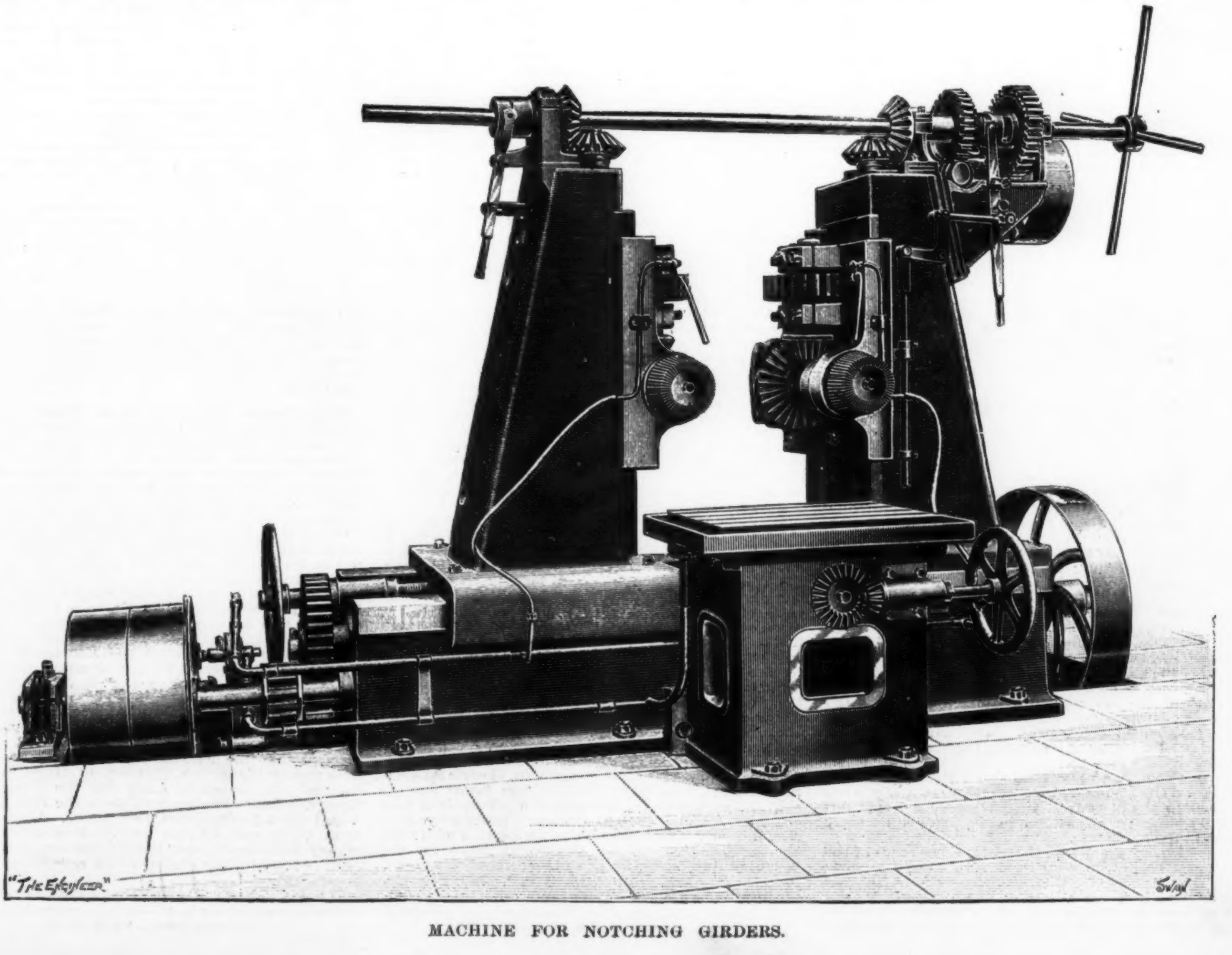
Ordinarily the "Goubet II." travels partially submerged on the surface, so that only its dome is visible. When near a hostile vessel the "Goubet" is sunk to a depth of 4 or 5 meters, or if necessary to a depth of 10 meters. When submerged the lookout can see nothing through the dome; for which reason a periscope is used when the depths are not great. It is of the utmost importance to maintain the vessel so far as possible at a constant depth. This is effected by an ingenious automatically operating apparatus comprising essentially a gage which indicates the water pressure and thus the depth at which the boat may happen to be. As the finger of the gage travels over a contact arc it breaks or completes an electric circuit and thus controls the water ballast pump.

The motor of the "Goubet II." is of 2 to 3 indicated horse power. In the latest type of vessel mercury sulphate batteries are used instead of accumulators, because the latter generate hydrogen gas which forms an explosive compound with air.

FIG. 2.—STERN OF THE "GOUBET II."

As the air in the interior of the vessel becomes vitiated by the breathing of the crew, it is pumped out of the boat, while fresh air from the compressed air supply is allowed to take its place. Carbon dioxide gas is absorbed by potash; while the moisture and organic products breathed out are absorbed by calcium chloride. Under these conditions the boat can remain under water for from ten to fifteen hours.

Tolls in Belgium.—Under date of September 2, 1899, Minister Newell transmits from The Hague copy of a law recently passed, according to which, from May 1, 1900, all State tolls on roadways, canals, harbors, sluices, and bridges, with the exception of two bridges, one roadway, and three military barriers, will be abandoned.



MACHINE FOR NOTCHING GIRDERS.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Resources of Asiatic Russia.—Siberia and the Amur lands are rich beyond belief. Their 13,400,000 square kilometers (5,213,956 square miles) are inhabited by only 4,000,000 souls. In recent years, however, the number of immigrants (400,000 last year) has been equaled only by the tide which poured into the United States in the past. This vast territory, long looked upon as a barren waste, is destined to be one of the world's richest and most productive sections. In northern France, wheat ripens in 137 days; in Siberia, in 107. Even strong night frosts do not injure the young seed. Under such conditions, the possibilities of agriculture are practically unlimited. I may add that oats require, in Siberia and in the Amur country, only 96 days, and in the regions of the Yenisei only 107. The frost period lasts only 97 days in the Irkutsk country. Transbaikalia lies entirely within the agricultural regions; so too almost the entire territory traversed by the Amur as far north as it runs. Efforts are being made to obtain along the Amur at least 300,000 square kilometers (115,835 square miles) for the higher forms of northern agriculture. Climatically, the best of northern Asia's territory, for planting purposes, is the Usuri country, which in spite of its vast tracts of wood and grazing lands, has 195,000 square kilometers (75,292 square miles) of arable ground. The building of the Trans-Siberian Railroad has already added to the empire's wheat product.

The mineral resources of western Siberia are vast. Between Tomsk and Koozenesk lie 60,000 square kilometers (23,167 square miles) of coal lands which have never been touched. The coal is said to be excellent. In eastern Siberia, with its 280,000 square kilometers (108,112 square miles) of fruitful soil, there are 400 places yielding gold. Rich mineral deposits—graphite, lapus lazuli; iron mines, particularly rich in quality (as high as 60 per cent.); hard and soft coals, i. e., black and brown coals—await hands willing to work for them. To-day, thousands of colonists are hurrying to these promising lands. Russia's output in gold and silver is already very large, and is constantly increasing. Three-fourths of all the silver gathered in Russia is obtained in the Altai Mountains. Exclusive of the Ural gold fields, there are 851 places in the empire where gold is found. Notwithstanding the number of places in which iron is located, there are only four large establishments for its production. The ores are rich—38 to 60 per cent. of raw iron.

The industries of Siberia are in their infancy; still, they are growing and are bound to grow, so rich are the rewards promised. Chemical, sugar, and paper mills have been put up in several places and are paying well. Even Manchuria, a province so vast that it might make an empire, is looking to Russia for its future development. The wealth of this province, like that of Siberia and all eastern Russia, is ripe for harvesting. The traffic in Siberia and eastern Russia is increasing faster than even the advocates of the great Trans-Siberian road anticipated. The Ob, one of the world's big rivers, emptying through the Gulf of Ob into the Arctic Ocean, has 102 steamers and 200 tugs running already. On the Yenisei, 10 steamers carry the mails regularly. The mouths of both these rivers were visited last summer by English and Russian ships. This proves the practicability of connecting eastern and western Siberia with Europe by water. The mouth of the Ob is to be deepened and wharves are to be built. On the coast of the Usuri country there is regular postal communication between Nicolajevsk, Vladivostock, and intervening places, as well as connection with Japanese ports and Port Arthur. From Odessa and St. Petersburg to various Asiatic ports runs the so-called volunteer fleet, established in 1878. It has 14 steamers with 115,500 tons displacement. In war they can be armed; in peace they carry freight, travelers, immigrants, and troops.

Siberia and the Amur country possess advantages very similar to those of North America, Australia, and parts of Africa. The great gain to Russia at present, in developing Siberia, is the guaranty that her harvests will come nearer to supplying her wheat needs.—J. C. Monaghan, consul at Chemnitz.

Roadside Fruit in Europe.—The cultivation of fruit trees along the highways of France is being extended each year, says Consul Hilary S. Brunot, of St. Etienne. The government having first set the example, the communes in certain departments adopted this practice as a source of revenue, so that now roadside fruit cultivation has become an important branch of national industry.

It is not, however, only in France that fruit trees have been planted along the roadside; in Germany, Belgium, and the Duchy of Luxemburg, the system has been greatly developed, giving satisfaction to the state as well as to local interests. On the routes of Würtemberg, for instance, the fruit harvest from this source produced in 1878 over $200,000, and last year the return had more than trebled. The annual revenue derived from the national roads of Saxony planted with fruit trees rose from $9,000 in 1880 to $42,000 in 1892, furnishing a total sum of $340,000 for the thirteen years. In Belgium, according to the statistics of 1894, over 4,630 kilometers of roads were planted with 741,571 fruit trees, which furnished the almost incredible sum of $2,000,000. In France, the production of fruit trees is estimated at $60,000,000.

In Westphalia, in the duchies of Baden and Saxe-Weimar, in Alsace-Lorraine, Switzerland, etc., the employes of the administration of roads and bridges and the road supervisors are instructed in fruit arboriculture. In some of the southern departments of France the roads are bordered with cherry trees, producing the small fruit called merise (wild cherry) much appreciated for making wine sui generis, preserves, and even alcohol.

In the Touraine, plum trees dominate; while in the Allier and the Limagne, the walnut trees transform the roads into shady walks. In Auvergne, the chestnut tree flourishes; while in Normandy, place is naturally given to the apple tree.

Some twenty years ago, the picturesque roads of the northeast of France were lined with stately poplars; but, although ornamental, their roots went far and wide, rendering the adjacent meadows sterile, and plows were continually stopped by offshoots lying almost at the surface of the soil. The farmers appealed in such strong terms that the communes decided the fall of the poplar, and soon axes and saws were brought into requisition and the roads cleared of these trees in favor of the humble, but more useful, mirabelle (small plum), to the great satisfaction of the villagers. Thousands of baskets of this fruit are shipped to Paris daily.

Some thirty years ago, the distillation of the mirabelle was unknown in the country districts; the people plucked it as food for their swine; but to-day, they have learned to make more profitable use of it. They distill it in large quantities and find a ready market for it. A quart of this alcohol, slightly perfumed, sold five or six years ago for only 20 or 30 cents; to-day, it brings not less than 50 or 60 cents, while in Paris the best kind cannot be obtained under $1.

American Trade Interests in Hong-Kong.—Since the opening of Manila to the markets of the world, the competition for the control of its prospective trade has been growing keener from month to month, says Consul-General R. Wildman, of Hong-Kong. As a result of the war, the eyes of the world have been turned toward the Philippine Islands and China. The British chambers of commerce in England early realized that their trade supremacy in the Far East was soon to be contested by the United States. They sent to China Lord Charles Beresford as their representative, who appeared before all the chambers of commerce on this coast and told them plainly that if England wished to maintain her commercial prestige in the Far East, her resident merchants must co-operate actively with the English manufactories at home, and the English steamship companies must be prepared to make some little sacrifices for a time, in order to meet the changed conditions brought about by the new competitor in the field. During the tour of this celebrated Englishman there was a great deal said on political topics, and the "open door" and "sphere of influence" were exhaustively discussed; but I believe that the great benefit to be derived from Lord Charles Beresford's visit will be commercial rather than political, and that the energetic stirring he gave to the lethargic waters of British trade will have a lasting effect. America has also had a commission on this coast, sent out by the Philadelphia museums, which, while it worked in a quieter way, will be of immense advantage to our exporters. Its representatives made themselves as well acquainted as possible with the complex conditions of Asiatic trade, and returned to America with their minds filled with the needs of this coast, and with the general principles which govern trade relations here. If I may be permitted to make a comparison between the trade operations of the English, Germans, and Americans, I would say that the Americans are less daring and less confident than the other two. The idea of even our largest manufacturers seems to be that they can commence on this coast in a small way and build up with the expectation that their ventures ought to pay from the start. There is only one way for American manufacturers to win their way here, and that is to thoroughly study the market, decide whether their goods are suitable, and then establish a house or agency large enough to command the respect of the great Chinese hongs and the consideration of the English and German firms that have been established here for years.

While I am not a merchant, I have been a student of trade conditions here for nearly nine years, and if I were asked to outline a plan of campaign for an American firm or an association of firms who are willing to spend a little money to test this market, it would be as follows: The firm should send a thoroughly competent business man, a gentleman who could meet gentlemen on an equal footing at clubs and at dinners. He should bring letters that would be received with respect by the heads of the big banks and the firms. A salaried commercial man or an employe would be of little value, as he would not be kindly received by the class of men that it would be in his interest to meet. There are certain requirements of the trade that are peculiar to this coast and to this climate, that would require his serious study and attention. I dwelt upon this fact at some length in my annual trade report to the department, dated October 20, 1898, which should be read in connection with these remarks.* In addition, I will here call attention to a phase of the Chinese trade that does not seem to be thoroughly understood or appreciated. For example, we will admit that the American manufacturer has a class of goods that would be acceptable to the consumer on this coast—possibly it may be piece goods. He persists in shipping it here in lengths and with chops, or trade marks, that are suitable to American markets. The Chinese merchant refuses to accept such parcels, as they would "cut to waste" in the manufacture of Chinese clothes. The wide-awake American, who should be sent out to study the trade conditions, can adopt a trade mark, or chop, which would be satisfactory, and further meet local views as to sizes and quantities. I do not mean that the Chinese are always fair in their objections. These are sometimes simply tricks to depress the market; still they must be met.

After the American firms have decided to enter this market, I would earnestly advise them to establish a big wholesale and retail emporium in Hongkong, the larger and more complete the better. It would have to be on modern lines, modeled to some extent upon our large establishments in the United States. If the store were made attractive, Chinese from all over the coast would flock in; and, as they never buy without first seeing the article, the advantage of such an arrangement would be immediate. Of course, this would require very large stocks to begin with, as selling to Chinamen by samples is impossible. As an instance of the classes of goods that would be salable in such an emporium, I might mention all kinds of cotton goods that are suitable to this climate; canned meats, fruits and vegetables, bottled beer, gunpowder, cheap lamps, bicycles, sewing machines, flour, kerosene, jewelry, engines and boilers for small steamboats, electric fans (direct current), wire rope, baled cotton (short staple), ship and roofing paint, asbestos, and all kinds of ship chandlery. In addition to these and many other articles, this city would support, in connection with such an establishment, a first-class retail store for the benefit of Europeans, which should embrace dry goods, furnishing goods, stationery, music, fishing tackle, sporting arms, racing outfits, and all kinds of provisions, including fresh butter. A leading capitalist told me, a few days ago, that such an establishment would be a success from the start, and would be the means of introducing American goods to the Chinese market more rapidly than any number of letters or small consignments. It must be a distinctly "American store," run by intelligent men, who would be satisfied only with a very large volume of business. Further, my informant said that when the business had once been established on a permanent footing, it would be very easy to incorporate it into a limited liability company, floating it entirely in Hongkong.

Within the last year, an American commission house has been established here—F. A. Blake & Son—which represents half a dozen or more California firms. It has met with gratifying success, and I hope may be the beginning of a larger enterprise. People are learning to appreciate American goods, and our manufacturers are finding out that they can compete in this market by sending over their surplus at a special export price. One of the leading architects here, writing to me on the subject of American competition, says:

"American manufacturers are, as you know, cutting into British and German trade here. In some tenders we received a few weeks ago for a large steel wharf, there was a difference of only £66 ($320) between the lowest tender (British) and the next lowest (American)—the former being f. o. b. Liverpool; the latter, f. o. b. New York. Had the price been c. i. f. here, the American tender (Carnegie's) would have been the lowest, owing to freight being cheaper here from New York than from Liverpool. The wharf was let for about £7,500 ($36,450)."

The new mills of the Hongkong Cotton Spinning, Weaving and Dyeing Company, Limited, will be in operation within a few days. This is the first cotton mill erected in Hongkong. For the last two months, between 800 and 900 hands, mostly women and girls, have been learning the mysteries of spinning cotton. The mill is fitted up with the very latest machinery, made in Oldham, England. There will be about 50,000 spindles, of which 8,000 are already at work. It is understood here that they are preparing to erect a plant for a duplicate mill, and the representative of an American firm, who was here figuring upon the proposition, told me that he could outfit the new plant for $150,000 less than they paid for the old one. As I have said in previous reports, this new industry will create a big demand for American "Upland" cotton. The only thing that the promoters of this English industry fear is that mills will be established in Manila, which would only be possible if Chinese labor were admitted freely.

The exports from this colony to the United States are steadily increasing. The exports for the quarter ended March 31, 1899, amounted to $1,565,610 gold, as against $718,030 in the corresponding quarter of 1898. While the bulk of these exports are in Chinese goods, there are a few items that may be of general interest. For example, matting, $89,330; rattan ware, $21,990; hemp, $133,490; rice, $325,250; refined sugar, $165,840; hardwood furniture, $24,185. In addition to these sundry provisions were invoiced in this consulate for Manila, amounting to $398,230. This last item is an object lesson in itself, as every article should have been sold by American firms.

German Printing Paper.—Consul Monaghan writes from Chemnitz, August 25, 1899:

Up to 1896, Germany's printing-paper exports had a rapid annual increase. Since that time, a falling off has been noticeable. In the ten years 1886–1896, the exports had about doubled. In 1896, they were 378,182 double hundreds,* worth nearly $2,230,000; in 1897, they were 321,368 double hundreds, worth $1,904,000; in 1898, they had dropped to 295,353 double hundreds, worth $1,761,200. The cause of this falling off is found in the very successful competition of United States paper makers. In 1896, Germany sent 10,490 double hundreds to the United States, and in 1898 only 2,617 double hundreds. Germany's exports of printing paper to Great Britain have fallen off since 1896 fully one-third. The decrease in exports of printing paper to Holland are even comparatively larger. A falling off was recorded in the exports to Australia and South America. The Argentine Republic and Japan are the only countries in which an increase was recorded. In 1898, 38,360 double hundreds were sent to Argentina and 40,743 double hundreds to Japan, against 30,927 double hundreds and 20,656 double hundreds, respectively, in 1896. If the markets to which Germany sends paper are carefully canvassed, there is no reason why our exports in this line should not continue to increase.

Westinghouse Works in Great Britain. — Consul Marshal Halstead, of Birmingham, writes: Contrary to the natural expectation that we would do all the "worrying" over the intention of the Westinghouse Electric Company to build works at Manchester, the proposition has not been received with favor in all quarters here, as is shown by the following comment of a correspondent of The Manchester Evening Chronicle:

"The announcement has been made, and with the usual flourish of the Yankee trumpet, that electric works, such as were never yet seen, are to be erected in Trafford Park, Manchester. This statement may be true, but it is hardly fair that British electric manufacturing concerns should have been so absurdly depreciated in this connection. As an instance, it is stated that the Westinghouse Company are now making four large electric generators for the Manchester corporation, which it is inferred no English maker could touch. As a matter of fact, Messrs. P. R. Jackson & Company, engineers, Salford, offered to make these very machines, and to comply with all the conditions set forth in the specification of the corporation. The order was given to the Yankee firm, notwithstanding the fact that the price of the Salford firm was only £800 pounds higher in a £70,000 job. However, it may interest your readers to know that the Westinghouse Company have come rather late in the day, as events will, I think you will find, soon prove. I suppose the next boom will be new Yankee locomotive works, simply because all our 'loco.' shops are crowded out with work at much higher prices than obtained elsewhere."

It is stated that 100 acres of land have been secured.

* See Commercial Relations, 1898, Vol. I., p. 1059.

* 1 double hundred = 220·46 pounds.

that the company's buildings will occupy 40 acres, that 5,000 men will be employed, that Lord Kelvin will be technical adviser, and that all the Westinghouse patents for England have been purchased. I am not certain but that the newspapers have said the purchase includes the patents for all Europe. At any rate, American customers of Westinghouse, who manufacture articles for European export, should find out, if they use as component a motor or an electrical fitting of Westinghouse manufacture, whether the sale of foreign patents is so absolute that it would interfere with the use in Europe of articles purchased from the American company.

Belgian Treatise on Flax Disease.—The following, dated August 3, 1899, has been received from Consul Atwell, of Roubaix:

Research into the nature of the malady known as flax burn has been made by the botanical laboratory of the Agricultural Institute of Gembloux, Belgium, and it is now known that this disease arises from a microscopic fungus growth living in the cells of the roots and the radical hairs of young flax plants.

In a circular addressed to the State agriculturists, Mr. Bruyn, Minister of Agriculture, has set forth the result of his researches. As the parasite is internal and subterraneous, there is no method of direct treatment. The use of different manures has not thus far given any satisfactory result.

The only remedy is to uproot the diseased plants and destroy them, so that the germs shall not spread; to abandon the culture of flax on the infected soil for at least seven or eight years; also to avoid planting turnips or colza in the soil thus abandoned, as these are thought to harbor the parasite.

Tin in the Straits Settlements.—The following, dated Singapore, July 19, 1899, has been received from Consul General Moseley:

The advance in the price of tin at this place since last December is extraordinary. It is claimed here that three-fourths of the world's production of tin is smelted in Singapore, and oxide of tin comes from the protected native states of the Malay Peninsula. Large shipments are made from here every week to the United States.

Flour in Madagascar.—In reply to a New York correspondent Consul Gibbs writes from Tamatave, August 3, 1899:

There are no importers of American flour at this place at present. Most of the flour used here comes from France, and considerable is also imported from Bombay by Indian merchants. Australasian flour is likewise imported. Last year, some American flour came here via Cape Town, South Africa, but the preferential duties are such now that other countries cannot compete with French flour.

The largest dealers in flour are French firms who supply the colonial government for the use of the soldiers in Madagascar, and it is specially stipulated in their contract that they shall furnish only French flour.

Correspondence on the subject may be had with the following firms at Tamatave: Messrs. Dadabhoy & Company, Messrs. Procter Brothers, Mr. Leon David, Mr. I. Dupuy, Mr. E. Giguel.

Correspondence with Messrs. David, Dupuy, and Giguel should be conducted in the French language. Messrs. Dadabhoy & Company have a branch office in the Coffee Exchange, New York.

Faulty Packing of American Goods.—Under date of August 9, 1899, Consul Hayden writes from Castellamare di Stabia:

American exporters not only do not properly pack their goods, but, even when especially requested to do so, fail to give that attention to the matter which the necessity of the case demands. Our people should remember that their responsibility ceases when the goods are "free on board" in the United States, and to trace an irregularity—not to use a harsher expression—is out of the question; for, even could it be located, the trouble and expense incident to the matter would outweigh the pecuniary interest.

I have succeeded in starting what promises to lead to trade in American bicycles and tricycles, and I gave especial directions to securely box the machine ordered. Instead of heeding the instruction, the machine was sent, not in a box, but in a crate. All the tools were stolen in transit, which caused a delay of six weeks and the cost of another set of tools, as they could not be had here. This has occurred in five instances.

Walnut Crop of Italy.—Consul Byington writes from Naples, August 1, 1899, that there will be a shortage of fully one-third in the walnut crop, as compared with last year's product; but the quality promises to be superior to the average of several previous years. Two-thirds of the crop, which will commence to be shipped from Naples about October 1, it is expected, will go direct to New York and the remaining third to Liverpool and London.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

MISCELLANEOUS NOTES.

A successful installation of wireless telegraphy has been established on one of the most dangerous parts of the Ushant coast between lighthouses some 35 miles apart, by Lieut. Tissol, of the French navy, on behalf of the French government. The system puts the Stiff lighthouse on the Isle of Ushant in communication with the new lighthouse on the Ile Vierge. We hear that other lighthouses on the French side of the channel are to be connected in the same way.

According to M. R. Bouilhac, a number of freshwater algæ which he enumerates can absorb a certain amount of arsenic acid in the form of arseniates without injury; these salts partially taking the place of phosphates. Among the algæ which possess this property are Ulothrixtenerrima, Protococcus infusionum, Dactylococcus infusionum, and Stichococcus bacillaris. With Schizothrix lardacea, arsenic acid appears to have even a more favorable effect on its growth than phosphoric acid.—Bull. Soc. Bot. France, 1899, p. 64; from Annales Agronomiques, 1898.

The first important discoveries of mines in Utah were made by soldiers under Gen. Connor, who established the military post at Fort Douglas, east of Salt Lake City, in 1863. His men were the discoverers of Bingham, Stockton, Little Cottonwood and other camps in Utah, and they also found mines at Pioche, Nev. The most important mining districts of the Wasatch are at those places, where the mountains are highest and most massive—where the granite has uplifted the quartzites and limestones and in the later porphyries have intruded the sedimentary rocks.—Mining and Scientific Press.

In order to deaden the noise of passing trains, the steel viaduct of the New York Central and Hudson River Railroad in Park Avenue, New York, built about two years ago, is now being ballasted throughout a length of one mile. The ballast is broken stone. The troughs in the floor are coated with tar before the ballast is put in. The sleepers are yellow pine, creosoted, 7 inches by 8 inches by 8 feet with tie-plates. The rails were laid directly on the floor of the bridge, with nothing intervening except insulating strips used to preserve the circuit of the electric current through the rails, which is used to control the block signals.

Glass plates cast with wire gauze inclosed in its substance, submitted to tests at the Chemnitz Technical Institute and the Vienna Technological Museum recently, were found to possess great consistency as well as resistance to pressure, shock, and the effect of heat, the resistance being 361 pounds per square inch, and the consistency 3,610 pounds per square inch of the transverse sectional area. While plates of ordinary glass frequently broke under the sudden application of pressure, the strengthened glass was only cracked; and the cracks caused by rapid changes of temperature permitted neither damp nor flame to pass. Glass so made has already been used for water gages.

The extraction of sulphur in Sicily, the principal producing country in the world of that article, gives occupation to no less than 30,000 persons. The production amounted to 3,000,000 tons in 1897, which grew to 3,200,000 tons in 1898. In the former year there were 642 works in operation and in the latter year 695. The exports of sulphur in 1897 amounted to 427,823 tons, and in 1898 to 462,393 tons. The increase was due mainly to larger demands from the United States on account of the war with Spain, though most of the sulphur cargoes were shipped in British vessels. The principal ports of loading were Emporia, in the province of Girgenti; Catania, Sicata and Palermo. In 1898 the principal buyers were the United States, 142,553 tons; France, 95,000 tons; continental Italy, 60,919 tons; Germany, about 27,000 tons; and Great Britain, with Malta, only 26,487 tons.

The tree yielding what is known in Mexico as "gum chicle," the base of most of the chewing gums manufactured in the United States, is valued in some countries as a fruit bearer. It is known botanically as the Achras sapota. It is described thus in Circular No. 15 (June, 1899) of the royal botanic gardens of Ceylon: "A small symmetrical tree with dark green shining leaves, native of tropical America. Fruit globular, about the size of a plant, with dark brown tender rind. When quite ripe it is considered one of the most luscious of tropical fruits, the pulp being sweet and refreshing and somewhat of the consistency of a pear. In India it is often sold under the name of mangosteen. Season, November to February. Thrives in the low country and up to 1,000 feet in deep and well drained soil. Propagated by seed and layering." Nursery plants sell at 25 cents in Ceylon. This fruit is known also as the sapodilla plum and naseberry.—India Rubber World.

Mr. P. V. McMahon has recently described to the Institution of Electrical Engineers the result of an elaborate investigation on the City and South London Electric Railway to determine the force required to start electric trains in tunnels and to keep them in motion. The observations show that the tractive resistance is forty pounds per ton of train at the moment of starting, but when a velocity of 6 miles an hour is reached, a force of only 10 pounds per ton is required to keep the train running. Between 6 and 13 miles per hour the resistance to motion is about the same, but at higher speeds it increases until a speed of 26 miles an hour is reached, when the resistance is about 21 pounds per ton. The resistance per ton of train as indicated by these results is high in comparison with similar results obtained on ordinary steam main lines. This is largely due to the resistance which the air in a tunnel offers to a train only slightly smaller than the tunnel. The friction of the air on the sides of the train forms a part of this resistance, but it is only a small proportion of the total amount—the resistance of the air at the head of the train in a tunnel being much greater. A few tests made by Mr. McMahon indicate that the air resistance in front of the locomotive itself is between 1 and 1½ pounds per square foot at a speed of about 14 miles per hour. The experiments indicate that a column of air is pushed in front of the locomotive, for where cross passages in the tunnel allow a free outlet for the air in front, the resistance experienced by the head of the train goes down almost to nothing.

TRADE NOTES AND RECEIPTS.

Very Firm Turkish Mortar.—Powder 2 parts of unslaked lime, sift and mix with 1 part of coarsely powdered brick dust. This mixture is stirred with water and applied in a thick layer as mortar. It becomes very hard, as remains of buildings from the Byzantine period prove.—Der Dekoration Maler.

A Mass Resembling Linoleum is Produced by a Rhenish Color Factory, with Employment of Roasted Leather.—The process consists in mixing roasted leather, or "Lederkohle," with oxidized linseed oil into a stiff paste, possibly with admixture of adhesive agents and gums, such as shellac, colophony, mucilage, tragacanth, etc. Same is then applied on a coarse fabric as skeleton and rolled or pressed.—Deutsche Maler Zeitung.

Production of Medicinal Soaps.—For the preparation of medicinal soaps cocoanut oil is principally adapted, from which Voiry produces a simple soap by boiling 900 grammes of the oil with 600 grammes of soda lye of 10° Bé. in a porcelain dish until the whole assumes a cream-like appearance. Next he adds 375 grammes of soda lye of 20° Bé. and arrests the boiling when a sample taken out and put on a cold body becomes solid. Now he adds about 500 cubic centimeters of distilled water, heating to a boil, and adding 375 grammes cooking salt. The soap rises to the surface of the liquid, is separated from the glycerine cooking salt layer by decantation after cooling, and cleaned by washing twice with a 20 per cent. cooking salt solution. Finally the author washes once more with cold distilled water, allows to drip off, and squeezes out the excess of water. He obtains thus a paste-like soap, which he employs for the preparation of the following medicinal soaps:

Borax Soap.—Rub up 900 grammes of simple soap and 900 grammes of sodium borate into an even mass, divide into pieces of 100 grammes each and press in moulds.

Tar Soap.—Gradually rub up 100 grammes of tar with 900 grammes of soap in a mortar. The same method is recommended for ichthyol and naphthol soaps.

Carbolic Soap.—Dissolve 50 grammes of white carbolic acid in about 25 grammes of alcohol (90 per cent.) and gradually rub up the solution in the mortar with 950 grammes of soap.

Sublimate Soap.—Dissolve 5 grammes of sublimate in 80 grammes of alcohol, filter the solution and incorporate with the soap as above.

Sulphur Soap.—Same is produced from 100 grammes of purified sulphur and 900 grammes of soap, like the borax soap.—Neueste Erfindungen und Erfahrungen.

Production of Luster Colors on Porcelain and Glazed Pottery.—The luster colors are readily decomposed by acids and atmospheric influences, because they do not contain, in consequence of the low baking temperature, enough silicic acid to form resistive compounds. In order to attain this, G. Alefeld has patented a process, according to which such compounds are added to the luster preparations as leave behind after the burning an acid which transforms the luster preparation into more resisting compounds. In this connection the admixture of such bodies has been found advantageous, as they form phosphides with the metallic oxides of the lusters after the burning. These phosphides are especially fitted for the production of saturated resisting compounds, not only on account of their insolubility in water, but also on account of their colorings. In an analogous manner titanic, molybdic, tungstic and vanadic compounds may be produced, however. The metallic phosphates produced by the burning give a luster coating which as regards gloss is not inferior to the non-saturated metallic oxides, while it materially excels them in power of resistance. Since the lusters to be applied are used dissolved in essential oils, it is necessary to make the admixture of phosphoric substance also in a form soluble in essential oils. For the production of this admixture the respective chlorides, pre-eminently phosphoric chloride, are suitable. They are mixed with oil of lavender in the ratio of 1 to 5, and the resulting reaction product is added to the commercial metallic oxide luster, singly or in conjunction with precious metal preparations (glossy gold, silver, platinum, etc.) in the approximate proportion of 5 to 1. Then proceed as usual. Instead of the chlorides, nitrates and acetates, as well as any readily destructible organic compounds, may also be employed, which are entered into fusing resin or resinous liquids.—Farben Zeitung.

Some Uses of Oil of Turpentine.—Oil turpentine is an excellent medium for restoring the gloss to patent leather shoes, and satchels rubbed with it are made to look like new.

Applied on a burn, where the skin is not yet open, turpentine quickly alleviates the pain.

A blister on the skin coated with it promptly disappears and is little painful.

Painters' aprons, soaked in turpentine twenty-four hours before washing, lose all oil paint spots.

A little turpentine (about a tablespoonful to 5 liters) added to the water on soaking the wash imparts a dazzling whiteness to the latter.

A flannel rag dipped in hot water and sprinkled with turpentine is a good remedy against hoarseness. This poultice is also employed for lumbago and rheumatism. For facial neuralgia it is also said to give relief, but must be used with caution on a tender skin.

A few drops of turpentine poured in boxes and closets will keep away moths.

Old rags soaked with turpentine and placed near mouse holes or stuffed into them completely drive away these animals. It is well, however, to renew the oil from time to time.

A few drops of turpentine added to the starch prevents flat irons from sticking.

In order to remove oil paint stains from clothes, they should not be washed, but be rubbed with a small narrow brush. Begin with the outer border of the spot, proceeding toward the middle, so as not to enlarge it.

Turpentine mixed with wax is known to give very good floor wax. A cloth squeezed out in turpentine restores the luster to oilcloth.

A mixture of two parts olive oil and one part turpentine gives an excellent furniture polish. It at once removes all finger marks, etc., from the furniture.—Färber Zeitung.

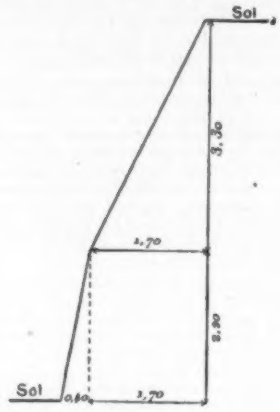
EXERCISES IN HORSEBACK RIDING AMONG THE CHASSEURS OF AFRICA.

Two years ago we reproduced some photographs showing an almost perpendicular descent made upon horseback by officers of the Italian school of cavalry of Tor de Quinto. Other journals have since then published photographs of a similar kind taken at the same Italian school of cavalry. It results from this that one might be led to think that upon this ground the French cavalry was unable to compete with its transalpine neighbors.

Apropos of this it is well to state that while with the Italians it is a question of choice horses selected with great care and ridden by officers or non-commissioned officers desirous of signalizing themselves by individual prowess, such work is done among the 3d Chasseurs of France by all the officers with small troop horses.

The hill represented in the accompanying figures is a declivity 18½ feet in height, of which the general slope is broken in the center, as shown in the diagram. The first part is a steep slope of 10¾ by 5½ feet, say an inclination of 2 to 1. The second part is nearly vertical: 7¼ feet by 16 inches, say about 6 to 1. The obstacle with sloping sides placed on the line of the steeplechases at the Auteuil hippodrome is a mere bagatelle alongside of such a declivity; and very few of our famous steeplechasers could descend the Tebessa hill without accident, except after long preliminary practice. The Arabian horses are as a general thing nervous and clever, but not very powerful. Those that are weak and lymphatic allow themselves to slide to the bottom. Those that are energetic jump in most cases nearly the entire lower part of the slope. Jumps of from 6 to 6½ feet are observed at every exercise. One of our engravings reproduces an instantaneous photograph of an exceptional jump of 8¾ feet downhill.

A large number of military races, as is well known, are contested at the hippodromes of Auteuil and Vincennes and at those in the country. In some of these officers mounted upon pure-blooded horses take part, and, in others, sub-officers saddled upon their army horses. In most cases these steeplechases are 1,500 yards in length, and the riders make their steeds clear the small obstacles with the sole thought in view of minimizing the jump so as not to slacken the pace. Would it not be preferable to lay out courses that would comprise serious obstacles—declivities, for example, such as that of Tebessa? The training of the horses and the skill of the riders would certainly be greatly increased.—L'Illustration.



GROUP OF FRENCH NON COMMISSIONED OFFICERS DESCENDING THE DECLIVITY OF 18 FEET.

EXERCISES IN HORSEBACK RIDING AMONG THE CHASSEURS OF AFRICA.

ON THE MANUFACTURE OF NITRITE OF SODA.

By M. A. DARBON.

DETAILS of the manufacture of nitrite of soda are very scarce in chemical literature; it will, therefore, be of interest to briefly describe the production of this substance, which is now very widely used in the dyeing industry. The raw material used in this manufacture consists of purified Chile saltpeter, and although the presence of sodic chloride may interfere with the value of the nitrite, the recrystallization of commercial saltpeter, with a view to the elimination of the sodic chloride, is not practiced, as the expenses connected with the operation would be too great.

The saltpeter is melted in large cast-iron vessels, an operation which includes the evaporation of the hygroscopic water, and the decomposition of a part of the iodides and iodates which accompany the saltpeter. At 310° saltpeter begins to fuse, and before adding the lead necessary for its decomposition the temperature is raised to about 400–420°.

The lead should be as pure as possible, as the presence of small quantities of other metals might cause the decrepitation of the whole charge; it is, above all, antimony which is the most to be feared; the lead used must be in thin sheets. About 280 parts of lead are necessary for 100 parts of saltpeter. As soon as the melted saltpeter has reached the desired temperature, the necessary quantity of lead is gradually added; at the same time the whole must be kept constantly stirred so as to obtain a very intimate mixture. It is necessary to carefully watch that the charge does not become too strongly heated, for fear the vessel might be pierced; in case of emergency, to prevent such an accident, a quantity of cold saltpeter must be added, or the fire withdrawn. When all the lead has been added the stirring must still be kept up for some time, and the melted mass is then removed by means of a large cast-iron ladle. It is then run in the form of fine threads into cold water in which its solution is helped by constant stirring. The decomposition of the saltpeter by the lead at 420–500° has the effect of producing, besides the nitrite, about 1 per cent. of caustic soda, which dissolves a certain quantity of the oxide of lead formed; this latter should also be removed. This is generally effected by neutralizing with nitric acid; in this manner saltpeter is reformed, while the oxide of lead is precipitated in the state of insoluble hydroxide. We may also use nitrate of lead or sulphuric acid for neutralizing the solution; sulphuric acid is preferable on account of its low price, but we then obtain sulphate of soda, which is deposited in the concentrating vessels in the form of the anhydrous salt. We thus have in aqueous solution nitrite, undecomposed saltpeter, caustic soda holding oxide of lead in solution, and the soluble impurities of the saltpeter, such as chloride of sodium, etc. The insoluble residue consists of oxide of lead, a very small quantity of metallic lead, which has escaped oxidation, and a certain portion of peroxide of lead. The solution diluted to about 6–8° Baumé is neutralized with nitric acid (or dilute sulphuric acid, or again with a solution of nitrate of lead); the oxide of lead in solution is precipitated, and the addition of the acid is continued as long as a precipitate is formed.

We may here correct an error which has slipped into most treatises on chemistry; most authors state that nitrite of sodium has an alkaline reaction, but this is not the case—the pure nitrite is absolutely neutral.

The neutralized solution separated from the insoluble residue by any convenient method is concentrated in cast-iron basins until it reaches 42–45° Baumé when warm.

The insoluble residue is thrown on a large filter of coarse material, such as sacking, washed with warm water, and the wash waters added to the principal solution. The residuary oxide of lead is capable of various applications, which will be dealt with directly. The concentrated solutions are added together in cast-iron vats and left to crystallize; if the crystals thus obtained are not pure they must be redissolved and recrystallized. The pure crystals are separated in a centrifugal machine, washed, dried, and packed.

The desiccation takes place in an oven, the temperature of which is carried to about 50°, and the crystals are packed in cylinders of double thickness of parchment paper.

The residuary oxide of lead may be either melted and cast as it is, reduced to the metallic state, or transformed into minium; it can also be used for the preparation of white lead, of nitrate, acetate, or other plumbic compounds.

The analysis of the nitrite is generally made with a titrated solution of permanganate of potassium. By dissolving 9·594 grammes of permanganate in 1 liter of water we obtain a solution, each c.c. of which is equal to 1 centigramme of nitrite of sodium.

The analysis is carried out in the following manner: A known quantity of the nitrite is rapidly weighed and dissolved in an Erlenmeyer flask of 150–200 c.c. capacity with about 80 c.c. of water. To this solution are added a few c.c. of dilute sulphuric acid (1 : 4), and it is then titrated. When the coloration begins to disappear with difficulty, a fresh quantity of sulphuric acid, much stronger than the last, is added, as there is now no longer any danger of nitrous acid escaping. The addition of the permanganate is continued drop by drop until the rose tint is permanent for about a quarter of an hour.

To hasten the final reaction, the solution may be heated toward the end of the operation to 30–40°. The analysis of the melted mass is carried out in the same manner as is that of the oxide of lead to see if the washing was thoroughly done.—Chemiker Zeitung.

Tests—tensile and crushing—were recently made in Bombay to ascertain the relative strengths of karri wood and teak. They resulted in favor of karri. It was also found that the cost of beams of karri would be rather less than rolled steel beams, while teak would be rather more, and that a solid timber beam 12 inches by 16 inches would make a more fire-proof floor than light rolled beams.

[Continued from SUPPLEMENT, No. 1243, page 19932.]

FIXATION OF CARBON BY PLANTS.*

THIS brings me to another interesting point on which I have already touched slightly—the enormous influence which slight changes in the carbon dioxide content of the air exert on the rate of its ingress into the assimilating leaf.

With a constant illumination, either in direct sunlight or diffuse light, the assimilatory process responds to the least variation in the carbon dioxide, and within certain limits, not yet clearly defined, the intake of that gas into the leaf follows the same rule as the one which holds good with regard to the absorption of carbon dioxide by a freely exposed surface of a solution of caustic alkali; that is to say, from air containing small but variable quantities of carbon dioxide the intake is directly proportional to the tension of that gas.

A single experiment will be sufficient to illustrate this.

A large sunflower leaf, still attached to the plant and exposed to a clear northern sky, gave an assimilation rate equal to 0·331 gramme of carbohydrate per square meter per hour, when air was passed containing an average amount of 2·22 parts of carbon dioxide per 10,000. When the experiment was repeated under similar conditions of illumination, but with air containing 14·82 parts of CO_2 per 10,000, the intake corresponded to an hourly formation of 2·409 grammes of carbohydrate per square meter. The ratio of the tensions of the carbon dioxide in the two experiments is 1 to 6·7, and the assimilatory ratio is 1 to 7·2, so that the increased assimilation is practically proportional to the increase in tension of the carbon dioxide.

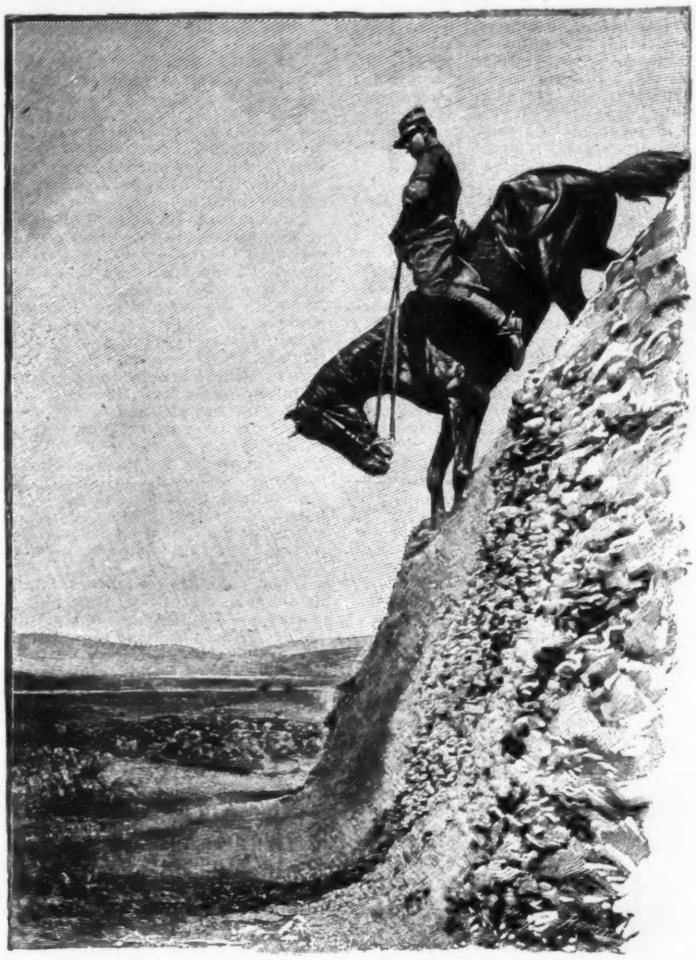
Since an increase of carbon dioxide in the atmosphere surrounding a leaf is followed by increased assimilation even in diffuse daylight, it is clear that, under all ordinary conditions of illumination, the rays of the right degree of refrangibility for producing decomposition of carbon dioxide are largely in excess of the power of the leaf to utilize them. Under natural conditions this excess of radiant energy of the right wave length must, from the point of view of the assimilatory process, be wasted, owing to the limitation imposed by the high degree of dilution of atmospheric carbon dioxide. But although the actual manufacture of new material within the leaf lamina is so largely influenced by small variations in the carbon dioxide of the air, we are not justified in concluding that the plant as a whole will necessarily respond to such changes in atmospheric environment, since the complex physiological changes involved in metabolism and growth may have become so intimately correlated that the perfect working of the mechanism of the entire plant may now only be possible in an atmosphere containing about three parts of carbon dioxide in 10,000.

We have commenced a series of experiments which will, I hope, throw considerable light on this point, but the work is not at present in a sufficiently advanced state for me to make more than a passing allusion to it.

The penetration of the highly diluted carbon dioxide of the atmosphere into the interior air spaces of the leaf on its way to the active centers of assimilation must, in the first instance, be a purely physical process, and no explanation of this can be accepted which does not conform to the physical properties of the gases involved.

Since there is no mechanism in the leaf capable of producing an ebb and flow of gases within the air spaces of the mesophyl in any way comparable with the movements of the tidal air in the lungs of animals; and since also the arrangement of the stomatic openings is such as to effect a rapid equalization of pressure within and without the leaf, we must search for the cause of the gaseous exchange, not in any mass movement, but in some form of diffusion. This may take place in the form of open diffusion through the minute stomatic apertures, which are in communication both with the outer air and the intercellular spaces, or the gaseous exchange may take place through the cuticle and epidermis by a process of gaseous osmosis, similar to that which Graham investigated in connection with certain colloid septa.

* Opening address by Dr. Horace T. Brown, F.R.S., President of the Chemical Section.



AN OFFICER DESCENDING THE DECLIVITY.

A DOWNWARD JUMP OF 8¾ FEET.

A SLIDE DOWNHILL.

EXERCISES IN HORSEBACK RIDING AMONG THE CHASSEURS OF AFRICA.

For many years there has been much controversy as to which form of gaseous diffusion is the more active in producing the natural interchanges of gases in the leaf. The present occasion is not one in which full justice can be done to the large amount of experimental work which has from time to time been carried out in this direction. Up to comparatively recently the theory of cuticular osmosis has been the one which has been more commonly accepted, free diffusion through the open stomata being considered quite subsidiary. In 1895, however, Mr. F. F. Blackman brought forward two remarkable papers which opened up an entirely new aspect of the subject. After showing the fallacy underlying certain experiments of Boussingault, which had been generally supposed to prove the osmotic theory of exchange, Mr. Blackman gave the results of his own experiments with a new and beautifully constructed apparatus, which enabled him to measure very minute quantities of carbon dioxide given off from the small areas of the upper and under sides of a respiring leaf, and also to determine the relative intake of carbon dioxide by the two surfaces during assimilation in air artificially charged with that gas. The conclusions drawn are that respiratory egress and assimilatory ingress of carbon dioxide do not occur in the upper side of a leaf if this is devoid of stomatic openings, and that when these openings exist on both the upper and under sides, the gaseous exchanges of both physiological processes are directly proportional to the number of stomata on equal areas, hence in all probability the exchanges take place only through the stomata.*

These observations of Mr. Blackman are of such far-reaching importance, and lead, as we shall see presently, to such remarkable conclusions with regard to the rate of diffusion of atmospheric carbon dioxide, that we felt constrained to inquire into the matter further, and for this purpose we employed a modified form of the apparatus which we have used throughout our work on assimilation. This was so arranged that a current of ordinary air could be passed, just as in Mr. Blackman's experiments, over the upper and lower surface of a leaf separately, the increase or decrease in the carbon dioxide content of the air being determined by absorption and titration in the manner I have already alluded to.

In this way we were able to employ comparatively large leaf areas and to continue an experiment for several hours, so that we had relatively large amounts of carbon dioxide to deal with, and the ratios of gaseous exchange of the two sides of the leaf could consequently be determined with considerable accuracy.

Our results, on the whole, are decidedly confirmatory of Mr. Blackman's observations. The side of a leaf which is devoid of stomatic openings certainly neither allows any carbon dioxide to escape during respiration, nor does it permit the ingress of that gas when the conditions are favorable for assimilation. On the other hand, when stomata exist on both the upper and under sides of a leaf, gaseous exchanges take place through both surfaces, and, as a rule, in some sort of rough proportion to the distribution of the openings. There is, however, under strong illumination, a greater intake of carbon dioxide through the upper surface than would be expected from a mere consideration of the ratio of distribution of the stomata.† Nevertheless, the general connection between gaseous exchange and distribution of stomata is so well brought out that we must regard it as highly probable that these minute openings are the true paths by which the carbon dioxide enters and leaves the leaf.

We must now look at certain physical consequences which proceed from this assumption, and see how far they can be justified by the known or ascertainable properties of carbon dioxide at very low tensions.

The leaf of Catalpa bignonioides is hypostomatic, and, therefore, takes in carbon dioxide only by its lower surface. Under favorable conditions it is quite possible, during assimilation, to obtain an intake of atmospheric carbon dioxide into this leaf at the rate of 700 c. c. per square meter per hour (measured at 0° and 760 mm.), corresponding to an average linear velocity of the carbon dioxide molecules of 3·8 centimeters per minute, supposing the intake to be distributed evenly over the whole of the lower leaf surface. This velocity is almost exactly one-half of that at which carbon dioxide will enter a freely exposed surface of a solution of caustic alkali. But if the intake of the gas is confined to the stomatic openings of the leaf, its velocity of ingress must be very much greater than this.

We have carefully determined the number of stomata occurring on a given area of this particular leaf, and also the dimensions of the openings, and find that the total area of the openings, supposing them to be dilated to the fullest possible extent, amounts to just under one per cent. of the leaf surface. It follows from this that the average velocity of the atmospheric carbon dioxide in passing through these openings must be 380 centimeters per minute, that is to say, just fifty times greater than into a freely exposed absorbent surface of alkali. In other words, supposing every one of the stomatic openings of this leaf could be filled up with a solution of caustic alkali, the absorbent power of the leaf as a whole would be only one-fiftieth of what it actually is when assimilating.

* There is one important fact to be borne in mind when considering how far these observations exclude the possibility of cuticular osmosis. In the many leaves we have examined, Mr. Escombe and I have found that the occurrence of stomata on the upper surface of the leaf is always correlated with a much less dense palisade parenchyma. The cuticle and epidermis under these conditions are in a much more favorable state to allow carbon dioxide to pass into the leaf by osmosis than when the closely packed palisade cells abut against the epidermis, as they do when this is imperforate.

† Granted that the stomata constitute the paths of gaseous exchange, it is clear that the amount of diffusion through them, other things being equal, must depend very largely on the extent to which they are opened. The delicate self-regulating apparatus which governs the size of the openings is so readily influenced, among other things, by differences of illumination, that à priori we should not expect the stomata on the upper surface of an isolated leaf to be in the same condition as those of the more shaded lower surface. This may very well account for the stomatic ratio of the two sides not being in closer correspondence with the assimilatory ratios, as found in most of our experiments carried out in bright sunlight. In light of lower intensity there is always a closer correspondence of the two ratios.

There is also another possible explanation of the fact. Since we have good reason to believe that the principal part of the assimilatory work is carried on by the palisade parenchyma, which occurs in the upper side of the leaf, the tension of the carbon dioxide in the air spaces of that part of the mesophyl is probably less than it is in the spongy parenchyma. There will, therefore, be a higher "diffusion gradient" between the carbon dioxide of the outer and inner air in the former case than in the latter, and this would certainly tend to a more rapid diffusion through the openings in the upper side of the leaf

These are some of the consequences which flow from an acceptance of the hypothesis of stomatic exchange, and it appeared to be impossible to accept that hypothesis unreservedly without some collateral evidence that these comparatively high velocities of diffusion are physically possible when dealing with such low gradients of tension as must necessarily exist when the highest amount of carbon dioxide does not exceed 0·03 per cent.

The well known general law expressing the rate of the spontaneous intermixture of two gases when there is no intervening septum was, as every one knows, established by Graham, and the more elaborate investigations of Loschmidt many years later served to confirm the general accuracy of this law, and to show that, within very narrow limits, the diffusion constant varies in different gases inversely as the square roots of their densities.

But a mere knowledge of the diffusion constants of air and carbon dioxide does not, as far as I can see, materially assist us in the particular case we have under consideration. In order to gain some idea of what is actually possible in the way of stomatic diffusion in an assimilating leaf, we must know something of the actual rate at which atmospheric carbon dioxide can be made to pass into a small chamber containing air at the outside tension, but in which the carbon dioxide is kept down almost to the vanishing point by some rapid process of absorption; and we must also determine the influence of varying the size of the aperture through which the diffusion takes place.

Our attempts to answer these questions experimentally have led us into a long investigation, which promises to be of wider interest than we had first imagined. I only propose to give on this occasion a general account of the results so far as they affect the physical question of the intake of carbon dioxide into the plant.

When a shallow vessel containing a solution of caustic alkali is completely covered, the air above the liquid is very speedily deprived of the whole of its carbon dioxide. If we now imagine a hole to be made in the cover of the vessel, carbon dioxide will enter the air space by free diffusion, and its amount can be very accurately determined by subsequent titration in the manner I have previously referred to. The time occupied by the experiment and the dimensions of the aperture being known, we can express the results in actual amounts of carbon dioxide passing through unit area of aperture in unit of time; or, since the tension of that gas in the outer air is known, we can express the average rate of the carbon dioxide molecules across the aperture in terms of actual measurement, say centimeters per minute.

We have made a very large number of experiments of this kind, using, in the first instance, dishes of about 9 centimeters in diameter, and varying the size of the holes in the cover, the air space over the absorbent liquid being always the same.

One of the most interesting problems connected with plant assimilation relates to the efficiency of a green leaf as an absorber and transformer of the radiant energy incident upon it.

It is already well known that the actual amount of energy stored up in the products of assimilation bears a very small proportion to the total amount reaching the leaf; in other words, the leaf, regarded from a thermo-dynamic point of view, is a machine with a very low "economic coefficient." We require, however, to know much more than this, and to ascertain, among other things, how the efficiency of the machine varies under different conditions of insolation, and in atmospheres containing varying amounts of carbon dioxide.

The measure of the two principal forms of work done within the leaf, the vaporization of the transpiration water on the one hand, and the reduction of carbon dioxide and water to the form of carbohydrates on the other, can be ascertained by modifying our experiments in such a manner as to allow the transpiration water to be determined, as well as the intake of carbon dioxide.

For the actual measurement of the total energy incident on the leaf under various conditions we are now using one of Prof. Callendar's recording radiometers of specially delicate construction, which will be ultimately calibrated in calories. This instrument gives promise of excellent results, but up to the present time the work we have done with it is not sufficiently advanced for me to describe. We may, however, obtain a very fair idea of the variation in the efficiency of a leaf from one or two examples in which the amount of incident energy was deduced from other considerations.

In the case of a sunflower leaf exposed to the strong sunlight of a brilliant day in August, the average amount of radiant energy falling on the leaf during the five hours occupied by the experiment was estimated at 600,000 calories per square meter per hour. The average hourly transpiration of water during that time was at the rate of 275 c. c. per square meter, and the assimilated carbohydrate, estimated by the intake of carbon dioxide, was at the rate of 0·8 gramme per square meter per hour.

The vaporization of 275 c. c. of water must have required the expenditure of 166,800 calories, and the endothermic production of 0·8 gramme of carbohydrate (taking the heat of combustion at 4,000 gramme calories) corresponds to the absorption of 3,200 calories. Thus, as the final result under these particular conditions of experiment, we find that the leaf has absorbed and converted into internal work about 28 per cent. of the total radiant energy incident on it, 27·5 per cent. being used up in the vaporization of water, and only one-half per cent. in the actual work of assimilation.

In strong diffuse light, such as that from a northern sky on a clear summer's day, the leaf has a higher "economic coefficient," using that term in relation to the permanent storage of energy in the assimilatory products. In one instance of this kind in which the total energy received by the leaf was approximately 60,000 calories per square meter per hour, it was found that 96 c. c. of water were evaporated and 0·41 gramme of carbohydrate was formed for the same area and time. This indicates an absorption and utilization by the leaf of something like 95 per cent. of the incident energy, of which 2·7 per cent. has been made use of for actual work of assimilation as against 0·5 per cent. in brilliant sunshine.*

From what I have said previously about the effect of increased tension of carbon dioxide on the rate of assimilation, it must follow that the "efficiency" of a leaf as regards the permanent storage of energy must, cæteris paribus, be increased when small additions of that gas are made to the surrounding air.

In one such instance, in which the air had been enriched with carbon dioxide to the extent of about five and a half times the normal amount, it was estimated that the "efficiency" of the leaf for bright sunshine was raised from 0·5 to 2·0 per cent.

Up to the present we have been regarding the efficiency of the assimilatory mechanism of a plant in reference to the total energy of all grades which falls upon the leaf. It is, of course, well known that the power of decomposing carbon dioxide is limited to rays of a certain refrangibility, and the researches of Timiriazeff, Englemann and others leave little room to doubt that the rays of the spectrum which are instrumental in producing the reaction in the chloroplastids have a distinct relation to the absorption bands of the leaf chlorophyl. By far the greater amount of the assimilatory work, probably more than 90 per cent. of it, is effected by the rays which correspond to the principal absorption band in the red, lying between wave-lengths 6,500 and 6,975.† If, therefore, we express the distribution of energy in a normal solar spectrum in the form of a curve, we have the means of approximately determining the maximum theoretical efficiency of a green leaf, that is to say, the maximum amount of assimilatory work which could be produced, supposing the conditions so favorable as to admit of the whole of the energy corresponding to this absorption band being stored up within the leaf.

The brilliant discoveries of recent years on the constitution and synthesis of the carbohydrates have not brought us sensibly nearer to an explanation of the first processes of the reduction of carbon dioxide in the living plant. The hypothesis of Baeyer still occupies the position it did when it was first put forward nearly thirty years ago, although it has, it is true, received a certain amount of support from the observations of Bokorny, who found that formaldehyde can, under certain conditions, contribute to the building up of carbohydrates in the chloroplasts.

The changes which go on in the living cell are so rapid, and are of such a complex kind, that there seems little or no hope of ascertaining the nature of the first steps in the process unless we can artificially induce them under much simpler conditions.

The analogy which exists between the action of chlorophyl in the living plant and that of a chromatic sensitizer in a photographic plate was, I believe, first pointed out by Capt. Abney, and was more fully elaborated by Timiriazeff, who was inclined to regard chlorophyl as the sensitizer par excellence, since it absorbs and utilizes for the assimilatory process the radiations corresponding approximately to the point of maximum energy in the normal spectrum. The view which Timiriazeff has put forward, that there is a mere physical transference of vibrations of the right period from the absorbing chlorophyl to the reacting carbon dioxide and water, is, I think, far too simple an explanation of the facts. Chromatic sensitizers have been shown to act by reason of their antecedent decomposition and not by direct transference of energy, and the same probably holds good with regard to chlorophyl, which is also decomposed by the rays which it absorbs. We must probably seek for the first and simplest stages of the assimilatory process in the interaction of the reduced constituents of the chlorophyl and the elements of carbon dioxide and water, the combinations so formed being again split up in another direction by access of energy from without.

The failure of all attempts to produce such a reaction under artificial conditions is, I think, to be accounted for by the neglect of one very important factor. We are dealing with a reaction of a highly endothermic nature, which is probably also highly reversible, and on this account we cannot expect any sensible accumulation of the products of change unless we employ some means for removing them from the sphere of action as fast as they are formed.

In the plant this removal is provided for by the living elements of the cell, by the chloroplast, assisted no doubt by the whole of the cytoplasm. We have here, in fact, the analogue of the chemical sensitizers of a photographic plate, which act as halogen absorbers, and so permit a sensible accumulation of effect on the silver salts.

When we have succeeded in finding some simple chemical means of fixing the initial products of the reduction of carbon dioxide, then, and then only, may we hopefully look forward to reproducing in the laboratory the first stages of the great synthetic process of nature on which the continuance of all life depends.

FORMOSAN CAMPHOR INDUSTRY.

THE camphor trade, that is to say, the manufacture of camphor, for some time past in the hands of German merchants only, has ceased to be of interest to any but Chinese and Japanese, the latter having in every way more facilities for handling this article in the interior. Although from time to time reports are received of robbery with violence perpetrated by banditti

* The principal factor which determines the amount of transpiration in a plant must be the amount of radiation falling on it. It is essential that the water-bearing mechanism should be able to keep up a good supply of water to the leaf lamina in order to prevent the temperature rising to a dangerously high point. This "safety valve" function of the transpiration current is not always sufficiently borne in mind, and we are too apt to think that the plant requires these enormous amounts of water in order to supply itself with the requisite mineral salts. The absolute necessity for the supply as a dissipator of energy will become evident by taking one or two facts into consideration. A square meter of the lamina of the leaf of a sunflower weighs about 250 grammes, and its specific heat is about 0·9. We have seen that the hourly transpiration in bright sunshine may be as much as 275 c. c. per square meter, requiring the expenditure of 162,800 calories, and it therefore follows that, if the loss of water were stopped, the temperature of the leaf would rise at the rate of more than 12° C. per minute. In making our experiments in glazed cases it has sometimes been very interesting to watch the result of any accidental stoppage of the water current in the leaf-stalk, and the almost instantaneous effect this has in destroying the leaf when the insolation is of high intensity.

† These limits are those of the band as measured by passing sunlight through the leaf itself. In an alcoholic solution of chlorophyl the band lies between λ 6,400 and λ 6,850. I must here express my thanks to Mr. Charles A. Schunck for having kindly undertaken to make these measurements for me.

up-country, most places where camphor is now manufactured can be considered as more or less quiet.

The British consul at Tamsui, quoted in The Board of Trade Journal, states that since it has been decided by the Formosan government to institute a camphor monopoly, production has materially increased, owing to the high prices ruling in Hong Kong during the last few months.

The monopoly was to come into force July 1, 1899, and from that date the government alone was to be allowed to purchase camphor from the producers. As they will only buy a certain quantity per annum, they will have absolute control of the working of camphor, together with all matters respecting the cutting down of trees, etc.

Permits will be issued to producers, and anyone having the proper concession papers, and who has taken out a license in due form, will be allowed to produce camphor.

The government will itself undertake the sale of the raw camphor, after production, in its unrefined state, and will dispose of it to purchasers at certain points to be determined upon by the government. These places will probably be Daitotei (Twatutia), Shinchiku (Tekcham), Tokoham, and the towns on the west coast where camphor has usually hitherto been deposited awaiting transport.

The government has already fixed the price of camphor for the period from July 1, 1899, to the end of the financial year at 30 yen (say £3) per 100 catties (say 133⅓ lb.) The consul is of opinion that this price would seem to be too low, and that it will very probably be raised for the following reasons:

If the government buys at 30 yen at the places of production, i. e., as it comes out of the stills, this would give the manufacturer only 2 or 3 yen profit, not taking account of possible and probable losses occasioned by typhoons or other causes; while if the government proposes to make its purchases at Daitotei (Twatutia), Shinchiku (Tekcham), and the other places mentioned, 30 yen would be quite insufficient to give a profit after deducting expenses for cost of transport from the stills and loss in weight. This last item alone would amount to at least 10 per cent.

The present monthly export to Hong Kong may be calculated at from 2,000 to 2,500 boxes from Tamsui, and say from 100 to 200 boxes from Kelung to Japan. Owing to the enhanced prices ruling in Hong Kong, in anticipation of the monopoly, the total export from the island has increased by about 600 boxes a month.—Journal of the Society of Arts.

AN ACOUSTICAL METHOD FOR THE DETERMINATION OF THE MELTING POINT OF FATS AND WAXES.

By EDWIN DOWZARD, F.C.S.

NUMEROUS methods have been proposed for the determination of the melting point of fats and waxes. In some the melting point is the temperature at which the fat undergoes a certain degree of softening, either sufficient to allow a plug of the sample contained in a cylindrical tube to be forced up by the pressure of water, or to allow the sample to form a globule.

When a capillary tube is used, there is some uncertainty as to whether the melting point is that tempera-

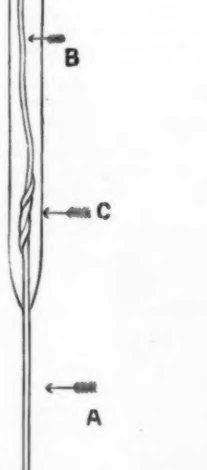


FIG. 1.

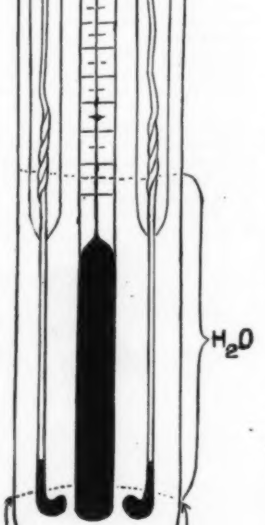


FIG. 3.

ture at which the fat commences to liquefy, or that at which it becomes clear and transparent.

On the Continent Pohl's method is frequently used. The bulb of a thermometer is immersed in the melted sample, and quickly removed, so that a thin coating only of fat adheres to it. After several hours the thermometer is inserted into a test tube so that the bulb is at a distance of half an inch from the bottom; heat is then gradually applied, and the temperature noted at which a drop of liquid fat is observed to form at the bottom of the bulb.

In nearly all the methods that have been proposed there is the method of personal equation.

The method about to be described, which eliminates the error due to personal observation, is based on the following: Two platinum wires, connected to a battery and electric bell, are coated with the fat or wax, and immersed in mercury, which is gradually heated; when the fat melts, the circuit is closed, which is indicated by the ringing of the bell.

Fig. 1, which represents the actual size of the original, consists of a piece of stout platinum wire, *A*, with a crook at the extremity, fastened to a long piece of copper wire, *B*; the platinum wire is fused into the glass tube, *C*, which is about 10 inches long. In the apparatus about to be described there are two of these wires identical in size and shape. The modus operandi is as follows: The sample of fat or wax is melted in a small

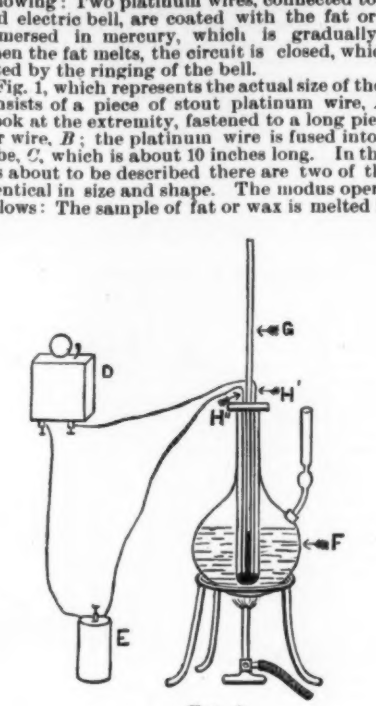


FIG. 2.

capsule, the platinum wires are dipped into the melted sample, taken out, allowed to cool, and the process repeated about three times; the wires will then have the appearance of A², Fig. 1. The coated wires are allowed to stand for three or four hours, and then placed in the inner tube of an Anschutz and Schulze melting point apparatus, Fig. 2, *F*, along with a thermometer. A quantity of mercury is now introduced into the inner tube, sufficient to allow the wires to be immersed to the top of the crook; water is then poured in until the bulb of the thermometer is completely covered. The outer flask is filled with water to the same level as the water in the inner tube. The wires are now connected with the battery and bell, and the temperature gradually raised; when within about 4 degrees of the probable melting point, the temperature should rise at the rate of about 1 degree in 70 seconds. The reading is taken immediately the bell rings.

Fig. 2 represents the complete apparatus. *H H'* are the wires, and *G* the thermometer.

Fig. 3 represents the bottom portion of the inner tube (full size).

Of course I do not claim this method to be original, as several chemists have proposed and described various modifications in the way of apparatus.

The above is simply the description of a modified form of apparatus which I have found to give useful and constant results.

THE REPLACEMENT OF FLUIDS INTO THE TRACK OF MOVING BODIES.

THIS is a converse case to the preceding discussion. Only in this instance, gravity alone is responsible for the action of replacement. The secondary lines of force radiating from the common center of displacement, however numerous they may be, must of necessity leave interstices, as they radiate in space. The particles of fluid filling these interstices move outward in unison with the adjacent particles, lying in the force lines, until their separation becomes great enough to overcome cohesion, then the intervening matter being free to move starts inward toward the axis of forward motion, and is uniformly accelerated by gravity. Now, considering the different relative positions occupied by these respective particles of fluid, in regard to that of a uniformly advancing point, situated in the same straight line as the points from which they start to move are located; a parabolic branch is again described, but in reversed position to that of the one of displacement. And, as this replacing action occurs simultaneously from all points in the periphery of the displacing section, the enveloping surface of a paraboloid is again developed.

This paraboloidal space, if not filled with the solid matter of the moving body, will be occupied by the fluid itself. This body of fluid is pressed against the receding disk by the resultant forces developed in the direction of its line of motion. And this pressure, due to gravity, being constant in its action (at the same level), the movement of this body of fluid is uniformly accelerated; so, no matter how fast the disk may move, the fluid will always be against it, for there is no "head resistance," the pressure being expended on the disk itself, and is the same case as if a body were moving in a perfect vacuum. If it were possible for the disk to instantly obtain its full velocity, a vacuum would result, and continue to exist, if enough speed were maintained. Then, an increase of the impelling force, according as the vacuum is more or less perfect, becomes necessary in order to maintain this velocity.

As the replacing force, gravity is altogether independent from the impelling force of the disk; it matters not whether the space developed be filled or empty, so long as the velocity remains unaltered the orbits of the returning particles remain unchanged. The air filling this space need not be "dead air," but is most commonly in rapid circulation.

Now as the developed paraboloid moves in unison with the advancing disk, the space traversed between first and second moment of consideration would again be void if it were not for the fluid moving inward from the surrounding space. These particles of fluid acquire the same uniformly accelerated velocity, traversing equal distances in equal periods of time, as bodies falling from a state of rest, hence their velocity depends in any particular case on the distance traversed; the distance from a point in the periphery of the advancing disk to its center of displacement. Hence this distance and the rate at which the disk moves determines the shape of the paraboloid generated, i. e., whether it be blunt or sharp. The relative length being directly proportional to the velocity.

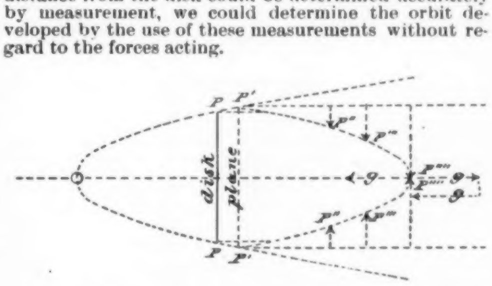
This is a reason why a rapidly moving vessel must have a longer "run" than one moving at slower rate of speed. As already deduced, the particles striking each other at the axis of motion give out rectangular resultants. If we consider two opposite particles of the fluid moving inward in the same right line, and confined to a plane of action that passes through the axis of forward motion, then will the resultant forces created by their contact be confined to the same plane of action, and there will be but two resultants, one acting forward, the other backward. As the two inward forces were each equal to gravity (g), their sum will be $2g$, and the resultants representing an equal division of this sum will each be equal to (g) the other. The force (g) that acts toward the disk helps to hold the conoid of fluid against the disk as before mentioned. The other force (g) acting backward is resisted by an equal force (g) acting forward, which represents the forward thrust of the replaced fluid. These two equal forces acting against each other, as far as this problem is concerned, may be said to cancel each other.

Now, if the fluid be air or gaseous, this later action is reflexive, producing compression, condensation, rarification, and sound. This accounts for the whistling sound associated with the flight of rapidly moving objects. If the fluid be water, then the reaction of these forces is shown in the formation of a ridge of water or wave, caused by lifting a portion of the water above its surface, and which has the appearance of following the moving object, as it is continuously generated or produced. The water is forced upward because of the lesser resistance of the atmosphere, the forces acting toward the point of least resistance. This also is the cause of vessels raising a bow wave, or wave of displacement at their stems, the upward resultants of the resistance and impelling force lifting it in this instance. When the course of the moving body is directly downward, the resultants acting backward in its course are for a time greater than the downward resistance of the fluid, and an upward current is created; this gives rise to the apparent ebullition of the water, such as is noticed when a stone is dropped into it. If the object fall swiftly enough, then a fountain-like jet is also thrown upward in its course at the instant of its disappearance beneath the surface.

The actions and reactions in both the displacement and replacement of fluids is precisely the same if the fluid is stationary and the object moves, or if the object is stationary and the fluid moves against it. Hence, try the experiment of holding a partially immersed disk at the surface of a rapidly flowing stream of water or oil; if the former be used, then grease the disk to insure smoother lines of action, or let oil flow on the water's surface. Also the disk must be held perfectly perpendicular to surface and course of the fluid. The flow must be rapid enough to develop an opening behind the disk. The disk used, if shaped on the immersed end in form of a circle, ellipse, or parabola, will develop a smoother surface of displacement.

Now, it will be observed that the replacing action, or inward movement of the water, does not occur immediately at the plane of the disk, but at some distance back of it in the edge or periphery of some imaginary plane parallel to the real disk. This fact is partly due to "inertia," or to the resistance of the particles of fluid to being turned from their established orbits, and, also, to adhesion, as before mentioned.

Should the velocity be great enough, this distance becomes very perceptible, amounting to several inches or feet, as the case may be. If the exact diameter of the plane developed at point of greatest width and its distance from the disk could be determined accurately by measurement, we could determine the orbit developed by the use of these measurements without regard to the forces acting.



If the movement be too slow, the space developed back of disk fills with water as fast as formed, but if rapid enough, then it is filled with air and water, the relative volumes of which are inversely as their densities, i. e., more air than water. It is hardly possible to apply enough power to the disk to develop a velocity that could produce a vacuum. There is no doubt but that the atmospheric pressure is greatly reduced in the immediate track of a projectile or shot, still not enough to produce a theoretically perfect vacuum. This track is at first filled with the gases of combustion, which follow along with it till condensation ensues.

Friction, as commonly considered, is made up of two factors, adhesion and pressure per unit of area. All pressures due to forces have already been considered in this problem, so we will have to deal with friction as with adhesion itself. As this is in direct ratio to the area of surface, the cross-section that develops the least surface will develop the least friction. The surface of the developed paraboloid is as the periphery of displacing disk when same speed is maintained. So also the section having the greatest area with shortest bounding line develops a paraboloid with greatest volume to area of surface evolved.

A 10-foot square, having an area of 100 square feet, has a perimeter of 40 feet. A 11·3-foot circle of same area (100 square feet) has a periphery of 35·5 feet, hence will generate less surface than the square. A rectangle of same area must of necessity have a longer

perimeter than the square, hence will generate a greater surface than any of the others. Also an ellipse of same area will have less periphery than a rectangle, and hence produce less surface.

Also a parabolic segment will have more area when erected on same base and height than a triangle, hence will have less periphery per unit of area than the triangle. A "convexed surface" must be generated on a base whose periphery is curved, hence "produces less friction" as a rule than surfaces not so shaped. From the above facts many practical inferences may be drawn.

For a body of given volume to move at a fixed rate of speed with least resistance it must have a regular cross-sectional area with least periphery, and completely fill out the lines developed by that section, both in the displacement and replacement of the fluid. The higher the velocity the smaller the cross-sectional area, and the longer the body must be. If the forward portion of the body conforms to and fills out the lines of displacement, and the rear portion does not so fill the lines developed, then a retarding force is created equal to the powers used in moving the additional volume of fluid along. If the case is reversed, then an equal waste of power occurs.

If a portion of the body project beyond the lines that would otherwise be established by its cross-section a new focus of displacement is established which requires as much additional power as if the void created by it were filled with solid matter. Hence, any projection on an object beyond the lines of disturbance established by its section helps to retard it accordingly.

In conclusion I might say that the general outlines of fish, birds, and insects do conform to the above facts. Furthermore, their bodies being slightly elastic can conform to slight variations of speed.

August 12, 1899. M. F. MITHOFF.

THE OLFACTORY NERVE TRACK.

THE human nose, containing the organ of smell, is situated above the mouth and the cribiform plate of the ethmoid bone. Communication with the atmosphere is had by means of the nostrils. The nose is divided into a right and left chamber by a vertical, mesial partition, from which it follows that, like the eyes and ears, the nose is a double organ. Bone and cartilage constitute the material of which the walls of the nasal cavity are formed. The cartilage forms the point, the allæ, or wings, and a part of the mesial partition. The lower lateral cartilage is connected by a fibrous membrane with the upper lateral cartilage running to the anterior edge of the upper maxillary.

Each nasal chamber is lined by a mucous membrane called the pituitary, or Schneiderian membrane. This membrane is prolonged into the meatus and the air sinus. The mucous membrane is divided into a respiratory and olfactory region.

The respiratory region is covered with a ciliated columnar epithelium and contains many racemose glands for the secretion of mucus.

The olfactory region is the seat of distribution of the olfactory nerve and its peripheral end organs. In the olfactory region, the mucous membrane is soft and thick. When vertical sections of the membrane are microscopically examined, the tubular glands discovered by Bowman may be seen in the vascular, connective-tissue layer. These glands contain roundish, secreting cells with yellowish-brown, pigment-stained contents. The epithelium is cylindrical, but not usually ciliated. Long, slender, ramified processes extend from the deeper end of each cell, sometimes as far as the sub-epithelial tissue. Between the epithelial cells the characteristic olfactory cells of Schultze are located.

The olfactory cell, as shown in Fig. 1, taken from Stein der Weisen, comprises a spindle-shaped body from which two long processes arise, the peripheral and central. The peripheral process passes vertically between the adjacent cylindrical epithelial cells to the free surface of the mucous membrane. The central process of the olfactory cell extends toward the sub-epithelial connective-tissue. Besides being finer than the peripheral process, it is further distinguished by a varicose appearance, similar to that of a nerve fiber.

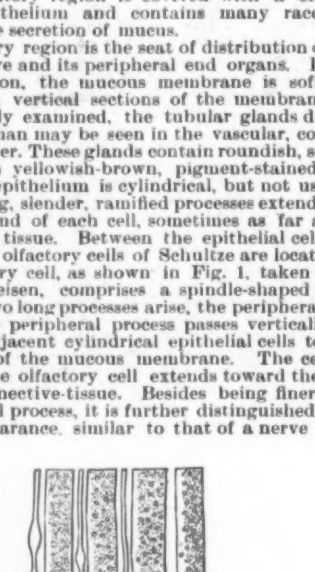


FIG. 1.—Epithelium of the Olfactory Mucous Membrane. *a a*, olfactory cells; *b b*, epithelial cells. (After Rauber.)

The olfactory nerves, which, united in bundles, pass through the passages of the ethmoid bone, ramify and extend over the olfactory mucous membrane after having again branched into nerve filaments. Each nerve filament is in turn composed of fibrils which can be easily separated from one another (Rauber). The fibrils are connected with the olfactory cell, but that the two are correlated has not as yet been proved.

In the meeting of the fibrils and nerve filaments the same process is presumably repeated which occurs in the union of nerve filaments in the spinal marrow. The olfactory nerve fibers receive through their fibrils the sensations conducted by the similar nervous processes of various olfactory cells.

The structure and function of the nerve track must be closely related to each other. From the structure conclusions can be drawn as to the function, and vice versa. But it happens that, so far as the sense of smell is concerned, the structure of the nervous apparatus is better known than its function. And the peculiarities of structure cannot be entirely comprehended without some knowledge of the function. The number of odors is exceedingly large, yet the various varieties have

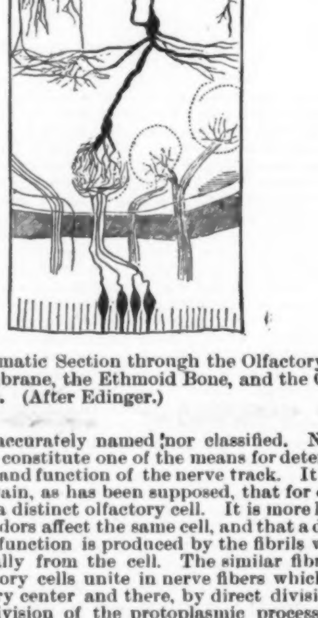


FIG. 2.—Schematic Section through the Olfactory Mucous Membrane, the Ethmoid Bone, and the Olfactory Bulb. (After Edinger.)

neither been accurately named nor classified. Nevertheless, odors constitute one of the means for determining structure and function of the nerve track. It is by no means certain, as has been supposed, that for every odor there is a distinct olfactory cell. It is more likely that similar odors affect the same cell, and that a differentiation of function is produced by the fibrils which spring centrally from the cell. The similar fibrils of various olfactory cells unite in nerve fibers which run to the primary center and there, by direct division or by indirect division of the protoplasmic processes of those cells, in which they enter as axis cylinders, produce a further and still finer division of similar fibrils. Simple odors have been classified by Frölich into six groups, each subdivided into two to six classes. This classification is not complete, because it does not include all known odors.

SERIES I.

1. *Oleum aeth. terebinthinæ.*
2. " " *juniperi.*
3. " " *cajeputi.*
4. " " *cumini.*
5. " " *carvi.*

SERIES II.

1. *Gummi ladanum.*
2. *Styrax.*
3. *Rosina quajacio.*
4. *Balsamum peruvianum.*
5. *Rosina benzoë.*
6. Vanilla.

SERIES III.

1. *Oleum rosmarini.*
2. " *lavandulæ.*
3. " *orygani.*
4. " *thymi.*

SERIES IV.

1. *Oleum aurantiorum.*
2. " *de bergamo.*

SERIES V.

1. *Herba patschouli.*
2. *Valeriana celtica.*

SERIES VI.

1. Garlic.
2. *Asafœtida.*
3. Carbon bisulphide.

In none of these series could the following odors be classified:

1. *Oleum caryopsillorum.*
2. " *cinnamoni.*
3. *Iris florentine.*
4. Musk.

Let it be assumed that the qualities of a certain series can be transmitted by an olfactory cell. These six series could be made to correspond with the six olfactory cells surrounding the epithelial cell; and the odoriferous qualities still lacking could be transmitted by those olfactory cells which exceed the number of six. But since Frölich's table is neither a complete nor accurate classification of odors, his six series might be reduced to fewer groups or all the sensations of smell might be reclassified into six to nine new series. Nevertheless, we should have to assume that the specific cells are situated at locally-confined parts of every portion of the mucous membrane; for the odoriferous particles breathed in have access to all parts of the mucous membrane, so that the sense of smell is fairly well distributed.

In the olfactory cell which communicates the first series of odors though the medium of *Oleum aeth. terebinthinae, juniperi, cajeputi, cumini, carvi*, related but, nevertheless, somewhat different chemical reactions are produced which are centrally propagated by the fibrils specially provided for this purpose, and each reaction is conducted not only by its specific fibril but also by the other four fibrils with more or less intensity. Since we do not as yet know what group of odors is associated with a cell nor the number of odors constituting a group, it may be that not merely five, but, what is more probable, a great number of fibrils have their origin in a cell. According to its intensity, every odoriferous impression is either agreeable or disagreeable; and it is very likely that among the quality-fibrils are interspersed particular fibrils for the transmission of sensations (Gefühl). The fibrils cannot all be equally developed, since those substances which affect the organs of smell more frequently than others will stimulate certain fibrils more than others.

As like fibrils tend to merge in a single nerve filament, so the fibrils sensitive to *Oleum aeth. terebinthinæ* unite with adjacent cells to form a nerve filament. And since the same phenomenon is repeated in other similar fibrils, it can readily be seen why a division of the central process, as well as of the nerve filament, must take place.

The olfactory bulbs rest on the upper surface of the cribiform plate of the ethmoid. The bulb contains both gray and white matter, and sometimes has the central cavity lined with ciliated epithelium. The gray matter contains fusiform and pyramidal nerve cells embedded in neuroglia. Between it and the central cavity is the white matter, formed of nerve fibers and interspersed with granules. Between the gray matter and the surface is the stratum glomerulosum of Meynert, consisting of coils of the olfactory nerve fibers interspersed with granules. The processes of the cells (Fig. 3) are continuations of the central track; the fibrils meet in nerve tracks which run to the olfactory bulb or to the protoplasmic processes of moderately sized cells, which are arranged in series (ganglion-cell layer).

Probably there are some peripheral nerve filaments which are not ramified, but run to the small cells of the coils as simple axis cylinders, and the division is effected primarily by the central conducting protoplasmic processes of the cells.

According to Edinger, the fibrils of the divided nerve filaments are connected with the protoplasmic processes of the ganglion cell layer. But if we adhere to the view that the ramification follows only from the division of fibrils like in function, then, in the latter instance, the protoplasmic processes of the central cells of the ganglion layer could be traced to a single coil. Since the cells of the ganglion layer are to be regarded as the greatest builders of nervous apparatus, and since connected tracks run together in the coils as we have shown above, the problem resolves itself into the differentiation of a definite species of odors to which several adjacent olfactory cells are sensitive. It is hardly likely that the cells of the ganglion layer can receive all kinds of central tracks, for their number is far too small.

The cortical center for the sensations of smell is the unicate convolution. That portion of the unicate convolution which is connected with the lobes also shows a cortical structure corresponding with the general form. At the beginning of the rhinencephalon there are deviations to be here considered only in relation to the pyramidal cells, which are to be regarded as the cortical terminals of the olfactory nerve track. In the third layer (layer of large pyramids) the central and smaller cells are lacking. In the region of the rhinencephalon the small pyramids of the second layer and the small cells of the third layer disappear, so that only the large pyramids are left. Since the fascia dentata, which has united with the rhinencephalon, is a cortical center for the sense of taste, the rhinencephalon is

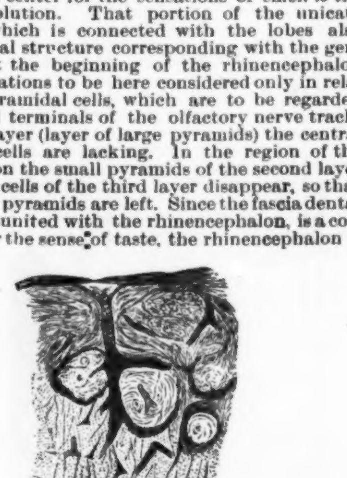


FIG. 3.—Sagittal Section through the Olfactory Bulb of a Dog. (Obersteiner.)

to be regarded as the center of those sensations of smell which usually accompany the sense of taste. Both senses are closely related and cortically connected. The other deviations in the structure of the cortex of both parts of the brain show a close association of the two centers.

The greater specialization for certain odors leads to the conclusion not only that small differences in odors are perceptible, but also that for some odors to which

the olfactory cells are but feebly sensitive, much more delicate sense tracks are formed. Hence is produced that graded system of pyramids which is found in the rear portion of the unicate convolution or gyrus.

In order to understand the deviating character of the pyramid layer of the cortical center of smell, a few words regarding the nature of odors and the effect which they have upon the olfactory organs are necessary. Odors there are which can be conveyed to the organ of smell only by the current of air passing through the nose. They can be perceived according to the degree of their intensity and to their qualitative grading, because they produce the reflex action of sniffing.

The sensations of smell produced during eating are not individually perceived, for they blend with the gustatory sensations. Their quality is, therefore, not to be distinguished. Nevertheless, they can be classified into several groups, the last of which again approaches those sensations of smell which are induced by the air current passing through the nostrils.

Among the foods and liquids can be distinguished those which only after mastication and swallowing intensively affect the sense of smell; those which in themselves are distinctly perceptible by the olfactory

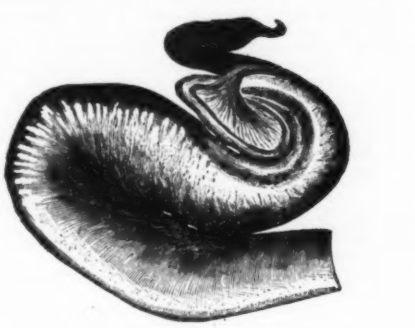


FIG. 4.—Section through the Region of the Rhinencephalon. (After Obersteiner.)

organs; and, finally, those which directly affect the organs of smell. The first variety of odoriferous sensations has its nervous apparatus strongly developed, owing to the frequency with which its impressions are made. Sensations belonging to this variety are closely related to the gustatory sensations, and their center is to be found in the rhinencephalon. In the second class are included those sensations which are excited by the air passing through the nose. They are but feebly perceptible and are not essentially different from those sensations accompanying mastication and swallowing. All the sensitive cells of the second class are located on the convex portion of the unicate convolution. In the third class the powerful sensations produced by the air breathed in can be again divided into species of sensations, and the system of large and small pyramids is completed. The sensitive cells of this last class are located somewhat to the rear of the unicate convolution.

The various classes of olfactory sensations are, hence, variously localized in the cortex of the rhinencephalon and unicate convolution. If all olfactory sensations could be arranged according to their quality in six series, they would also be localized in six different places. The sensations of one series are again divided into species of sensations, for which there are various nervous apparatus and terminal cells from which spring the pyramidal cells at the corresponding center. A limited localizing center of the cortex of the brain consequently represents a definite genus of olfactory sensations; and a series of pyramids from the largest in the lower layer to the smallest in the uppermost layer represents a class of sensations together with their

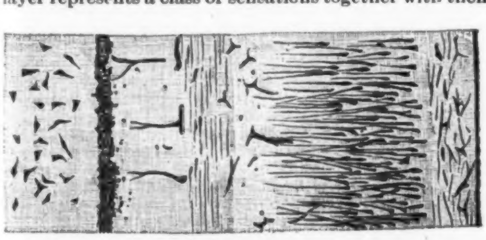


FIG. 5.—Cortex of the Rhinencephalon and a Portion of the Fascia Dentata. Stained with Carmine. Magnified twenty times. (Obersteiner.)

species, in which, however, the individual series of pyramids can be distinguished as little as the centers of localization of the genera.

Since the year 1897 petroleum residuals have been used as fuel in the Nytvinsk factory of the Kamsk Company in Russia, in the manufacturing of sheet iron. The chief difficulty to be contended with in this manufacture is that of obtaining an even temperature over the rolls. With the introduction of petroleum furnaces this lack of uniformity has apparently been overcome and the heat is evenly distributed over the whole plate, while air is admitted in the right proportions so that oxidation of the iron is prevented. The construction of the furnace used differs very little from the usual gas furnace. At the back of the furnace arch is an opening which admits an oil sprayer. This sprayer is so arranged that it can be moved in any direction, while there is no possibility of air entering except through the sprayer. The products of combustion travel through the side flues and thence to the chimney. Each furnace has its own chimney. As a rule the chimney is short, as with petroleum fuel less draft is required, and the fire can be so regulated that practically no smoke is observable. At the back of the furnace an opening is made to regulate the temperature and to increase or decrease the supply of fuel and air. As a rule, the petroleum furnace is heated very rapidly—that is, it is ready for working in from 2½ to 3 hours, and not more than from 4 to 5 cwt. of petroleum are required for every three blooms dealt with.

UPHOLSTERER BEES.

"IN the beginning of July, 1736," says Reaumur, "the lord of a village near Andelys came to see Abbot Nollet, accompanied by, among other domestics, a gardener who had a look of great consternation. He had visited Paris in order to announce to his master that a spell had been cast upon his land. He had had the courage (and it required some of this to do it) to bring the material which had convinced him, as well as his neighbors, of the fact, and which he thought was calculated to convince the entire universe of it. He claimed that he had shown this to the curate of the place, who was not far from thinking as he did.

"Upon seeing the material, however, the master did not become so frightened as his gardener could have desired. Although he did not remain absolutely calm, he judged at least that there might be nothing but a natural phenomenon involved in the matter, and thought it his duty to consult his surgeon. The latter, although skilled in his profession, was unable to throw any light upon a subject that had no relation with those to which his studies had been directed; and he therefore mentioned Abbot Nollet as being very capable of deciding whether natural history did not offer something similar to that which was presented to him. It was his answer, therefore, that was the cause of the call upon Abbot Nollet that has served to instruct me. The gardener soon placed under the abbot's eyes some rolls of leaves which, according to him, could have been formed only by the hand of a man, and he a sorcerer. Besides saying that it did not seem to him as if an ordinary man was capable of executing anything similar, he inquired for what good he had made the things, and for what purpose he had buried them in the earth at the top of a furrow. A sorcerer alone could have placed them there, in order to make them serve for some sort of witchcraft. Abbot Nollet assured the man that this remarkable work had been done by insects, and, as a proof of this, he extracted a large worm from the rolls. As soon as the peasant saw this his gloomy and perplexed air disappeared, and a look of joyfulness and contentment spread over his countenance, as if he had just been drawn from a frightful peril."

This curious anecdote relates to an insect of the genus Megachile that one may often have an opportunity of observing in gardens, and the aspect of which is that of a bee of grayish color. Its history is now well known.

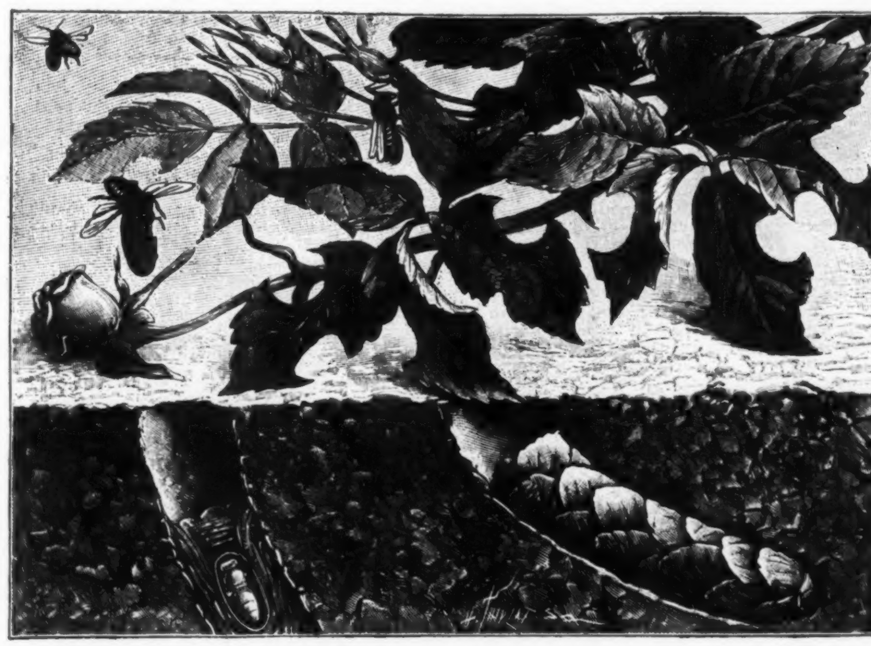
Every one has remarked that in gardens the leaves of the rosebush or lilac often contain curious apertures, some round and others elliptical and of almost mathematical regularity. It might be thought that such apertures had been formed by means of a pair of scissors or of a punch. The artisan by whom such cutting is done, however, is the Megachile, which carries away the pieces removed in order to upholster its nest therewith. This insect seems to have the geometrical instinct innate, since it cuts out its circles and ovals in such a manner that they adapt themselves exactly to the nest. It is, therefore, necessary that the insect shall remember the diameter of the latter. After the piece has been cut from the leaf, the Megachile takes it between its hind legs and flies away with it.

The nest is established in some cavity which is not the work of the insect itself; but which has been made by some other animal and afterward abandoned. Sometimes it is a gallery of an Anthophora, sometimes the hole of a large earthworm, sometimes the cylindrical passage bored in wood by the long-horn beetle, sometimes the habitation of the Calicodoma, and at other times a hollow reed, or even a hole in a wall. The Megachile contents itself with filling up such cavities with the pieces of leaves, honey and pollen, the whole arranged with an order such as has been described to us by Fabricius apropos of the white striped Megachile, which nidificates especially in the hole of the earthworm, of which it utilizes but about eight inches of the anterior portion. Before forming its first honey receptacle, it obstructs the passage with a strong barricade composed of leaves massed without much order. It is not rare to find in the rampart of leaves some dozens of pieces rolled into cornets and placed one within the other. The pieces that compose these are rudely shaped, and are cut from thick leaves, such as those of the grape vine.

Immediately after the defensive barrier comes the series of cells, which are very variable in number, say from five to twelve on an average. No less variable is the number of pieces assembled for the formation of a nest, and which are of two kinds—one elliptical for making the honey receptacle, and the other round to serve as a cover. The first, which are eight or ten in number, are not of equal dimensions, and, in this respect, are classified in two categories. Those of the exterior, which are the larger, embrace, nearly every one of them, a third of the circumference and slightly overlap one another. Their lower end is incurved so as to form the bottom of the cell. Those of the interior, which are notably smaller, thicken the wall and fill the empty spaces left by the first. The leaf-cutter therefore knows how to modify the work of its scissors according to the work to be done—first cutting the large pieces, which rapidly advance the work, but leave interstices, and then cutting the small pieces which are adjusted in the latter. There is another advantage that results from cutting the pieces of unequal size: As the three or four pieces of the exterior, the first put in place, are the largest of all, they project at the mouth, while the following, which are shorter, recede somewhat. In this way is obtained a rabbet which maintains the circles of the operculum and prevents them from reaching the honey when the bee compresses them into a concave cover.

After the insect has filled this receptacle with a mixture of honey and pollen and deposited an egg therein, it places thereupon a cover composed solely of round pieces of varying number. Sometimes the diameter of such pieces is of almost mathematical precision, so that the edges rest upon the rabbet.

After one nest is finished, the bee constructs another one above it, and so on, and terminates the series of nests by a barricade analogous to the one at the lower part.



UPHOLSTERER BEES.

Fabricius made numerous investigations concerning the leaves used by the Megachiles and came to the conclusion that for the construction of their nests, the leaf-cutters, each according to the taste proper to its species, do not visit one particular plant to the exclusion of others, but that the leaves employed vary according to the surrounding vegetation. Any kind of leaf proves acceptable to them, that of the exotic as well as of the indigenous plant, provided that the piece cut is convenient to use. Certain Megachiles even use petals instead of leaves. This is the case, for example, with the Megachile imbecilla, which often constructs its nest with the petals of the common garden geranium. This exceptional case is normal in an allied genus, that of Anthocopa, one of the species of which forms a nearly vertical burrow in the beaten roads that separate fields, and constructs but a single cell to the nest. It lines the interior with the delicate purple petals of the corn-poppy. The structure formed is a genuine bag, which the insect closes at the top by turning down the edges and covering the whole with earth. As remarked by Maurice Girard, the progeny of the poppy Anthocopa merit the pompous name of "porphyrogenetes" which the Greeks of the Lower Empire gave the sons of their emperors when they were born in the purple, while their fathers occupied the throne of Constantinople, that last remains of the Empire of the East.—H. Coupin, in La Nature.

P. L. Narasu received at Madras two samples of aluminum iodide in hermetically sealed glass tubes, from a German firm. While one of the tubes was being passed round a class, the other—lying on the demonstration table—suddenly exploded, and its contents were thrown out. Prior to the event both tubes appeared to be perfectly sound, and there was no reason to suspect that the volatile compound had formed an explosive mixture with air. The temperature of the lecture room at the time the explosion took place was nearly 95° F.—Nature.

[Continued from SUPPLEMENT, No. 1243, page 19935.]

EVOLUTION OF TECHNICAL EDUCATION IN ECONOMICS, POLITICS, AND STATECRAFT,

AND THE WORK OF THE FRANKLIN INSTITUTE DURING SEVENTY-FIVE YEARS.*

By ROBERT H. THURSTON, Corresponding Member of the Institute and Director of Sibley College, Cornell University.

WHILE common schools, as we know them, were organized in the older States during the Colonial period, and in the newer States with the adoption of their constitutions and the formation of their State or even of their territorial governments, it was not until about 1825 that the condition of the country, industrially and politically, had become so well settled that the attention of the people could be given without distraction to the solution of the great problems involved in their thorough organization. Since then our present universal and remarkably efficient common school education has taken shape and has come to constitute the foundation of all secondary and higher education, liberal, classical, even technical and professional. To-day the whole population of our country is at least educated in the common schools if not in the higher departments of our school and college system. This is the solid and enduring basis of the intellectual and social, and largely even of the moral, life of our nation.

The organization of the great technical schools of Europe, the progenitors of our own technical and industrial schools, may perhaps be properly said to have begun with the inauguration in 1785 of the French "Conservatoire Imperial des Arts et Metiers," as it is officially called. The establishment was, in 1793, placed in the hands of a "Commission Temporaire des Arts," and, still later, the present title was conferred upon it by a decree of the Convention Nationale. The commission temporaire was fortunately able to preserve the splendid collections uninjured during the disturbed period of revolution in which they had charge of them, and even procured from the convention a decree making their charge a depot public and authorizing the appointment of three "demonstrateurs" and a designer to conduct a course of instruction. A little later the whole establishment was domiciled in the old priory of Saint-Martin des Champs. On its faculty lists have been numbered many of the greatest names known to France and the world—Thenard, Charles, Darcet, Dupin, Clement, Berthollet, Gay Lussac, Arago, Pouillet, Poncelet, Ollivier, Becquerel, Moll, Alcorn, Tresca, and Morin are names familiar throughout the civilized world.†

The Conservatoire was not actually constituted a school of technical instruction, however, until 1819, and it has never been a school for the workingmen of France, but has been devoted to the education of students for the higher positions in the industrial system and to the training of professional engineers.

A more typical example of the form of industrial school which is most effective in the development of manufactures and the arts is the later "Ecole Centrale des Arts et Manufactures," founded at Paris in 1829. This school was taken in charge by the government in 1858, and has since that time formed a part of that general system of industrial education to which France so largely owes her present position as a wealthy and prosperous nation. Students from all parts of France, and from other countries as well, are admitted. Although large numbers of the students are foreigners, this institution remains, as it was said by M. Morin and M. Tresca, "pour l'industrie, une des forces principales" of France.‡ Founded originally by an association of scientific men, which included MM. Dumas, Peclet, Ollivier, and others hardly less distinguished, it stood unaided nearly thirty years and finally became one of the pillars of the state, and to-day furnishes a large proportion of the civil engineers of France.§

Other schools—as the Ecole Polytechnique, l'Ecole des Ponts et Chaussees, at Paris, l'Ecole des Mines, at St. Etienne, and that at Alais, l'Ecole des Arts et Metiers, at Chalons, those at Aix and elsewhere, and the Ecoles Industrielles at Mulhouse, Lyons, Lille, and in other cities—aid in making the system of industrial education of France admirably perfect. These schools, with the exception of the Ecoles Industrielles, are under the direction of the state.

The trade schools are usually founded by municipal authority and are under the direction of the city governments creating them. They fit young men to become good workmen and excellent superintendents. They are devoted peculiarly to instruction in the practical operations which constitute the trades. The Polytechnique, which is, in a certain sense, the highest of the French technical schools, is largely, perhaps principally, a school of mathematics and of the pure allied sciences. L'Ecole Centrale is the highest of the properly so-called industrial schools, and educates leading manufacturers and the directors of great industrial establishments.

The trade schools of Chalons, Aix, and Angers were organized by a decree of December 30, 1865, for the instruction of all workers in wood and iron, and are only allowed to receive resident pupils, who are selected from among applicants for admission by a competitive examination.

The German schools in which engineers or artisans are trained may be reduced to the following groups:

1. Polytechnic or technical high schools, in which the principles and practice of engineering are taught, sometimes with the aid of a workshop, but generally without it. The graduates aspire to be managing engineers of mines, railroads, manufacturing establishments, etc., each according to his special preparation.

2. Intermediate technical schools subdivided into (1) general technical schools, (2) weaving schools, (3) industrial art schools. The general technical schools may be classified into (a) higher elementary technical schools, (b) secondary technical schools, (c) building and mining schools. The graduates of these schools expect to become foremen in shops and works, with the possibility of attaining to a manager's position.

3. Apprenticeship schools for the training of skilled workmen.

4. Evening schools, available for artisans. These are attended by men who during the day follow their craft. The Fortbildungsschulen, or continuation schools, belong in this category.

5. Trade and professional schools for women.

This classification may be still further simplified in relation to mechanical engineers, foremen, and artisans, and all schools devoted to their service will fall under one of the following heads: (1) Polytechnic schools, with or without workshops; (2) secondary technical schools; (3) apprenticeship schools; (4) trade schools.

For admission, the polytechnics require sometimes more than the equivalent of an American college course, as the Ecole Polytechnique; sometimes the equivalent of a full course at the Realschule, as at the German polytechnics; sometimes, the best that the preparatory schools can give, as at the Imperial Institute of Technology at St. Petersburg. The range and severity of the requirements for admission gradually diminish till in the apprenticeship schools only the rudiments of knowledge are demanded.*

The "Gymnasia" in Germany are preparatory schools for the "Polytechnicum" as well as for the university; but the special preparatory schools for the former are usually the "Realschule."

In Europe, the custom has come to be almost universal to isolate the technical schools from the classical institutions and older universities. This has come about partly through the conviction that better work will be done by each class of college if allowed to work unhampered by the different methods and even the conflicting views, feelings, and traditions of the other; partly, perhaps, in consequence of their different foundations. Many able men favor both systems, and the amalgamation of the university and the technical school is likely to be given faithful trials here and there on the Continent, and in Great Britain perhaps still more completely; but they are to-day practically separately administered in nearly all cases. The view of the relative importance of manual and of gymnastic training of the mind which prevails generally in Europe is that, in the higher schools of technology at least, the training of the hands constitutes no part of the essential education of the engineer even, and that these schools should confine themselves entirely to the instruction of the student in the principles of his art, avoiding the practice so far as it involves the use of the hands. It is, perhaps, a consequence of this belief and practice that the states of Europe have been, for years past, flooded with well-educated, untrained young aspirants for entrance into this vocation who not only have been unable to find employment, but who have, in many instances, been informed by employers that they are not wanted. It is the man who suitably unites theoretical and practical knowledge and training who is wanted and who best succeeds, in Germany no less than in the United States. The view held by so many of the higher schools of Germany and of France is that formerly inspiring the "Ecole Polytechnique" at Paris, the first institution working on the highest theoretical plane produced in Europe.

Throughout Germany, technical schools and colleges and trade schools are distributed so numerously that the visitor from the United States is not only impressed by the completeness of the system and by its universality, but is oppressed by the apprehension that his own country, unprovided with such efficient and essential means of giving to the people a good industrial education, and apparently having few citizens who understand the bearing of that fact upon the future prospects of the nation as well as upon the character and attainments and upon the happiness and prosperity of the people, is likely to suffer severely when, in the near future, direct competition with this educated and trained nation of artisans shall produce those sad consequences which history has over and over again warned us against.

Long after their northern neighbors had inaugurated the new systems and methods of education the Swiss commenced on a similar plan, and established a noble school at Zurich, where they placed some of the greatest instructors in Europe, and opened their "Polytechnicum" to students from all parts of the world; more than one-half the pupils are from other countries. The faculty consists of over a hundred professors, assistants, and private teachers, and the number of students is above one thousand.

In Great Britain, the government and the people of that country have initiated trade schools and technical and industrial instruction in a few cities, and in connection with such institutions as King's College, the University, and the Crystal Palace schools, in London; Owen's College, Manchester; Trinity College, and others.

American schools, so far as developed in the United States, have been established, usually, by the several States or in compliance with an agreement entered into with the United States government under the terms of the Morrill act of 1862, the "Land Grant Bill."

Three-quarters of a century ago the people of the United States entered upon one of those periods of renaissance in education which, at intervals of a few years, have marked the progress of educational work in this country, and "manual labor" schools were established in many places, in which the college course of education was accompanied by a course of manual labor, either with or without compensation. A "Manual Labor Academy" was opened in 1829 at Philadelphia, which was said to be remarkably successful, the students employing their hours of rest from study in various kinds of bodily work. Every invalid resorting to this academy in the year 1830 was restored to health.

A number of the States were provided with such schools by legislative action, and in several others private enterprise did what the State governments had not done in this way. Among others, the Stockbridge Academy, in New Jersey, introduced this change into its programme, and Gerrit Smith secured a similar arrangement for New York State at Peterboro.

A report to the House of Representatives of Pennsylvania, in 1832, indicated:

1. That the expense of the education could thus be reduced one-half.

2. That three hours' work per day had an important beneficial effect upon the health and strength and in promoting good spirits among students.

3. That it had an equally useful effect upon the intellectual advancement of students.

4. That such a system is advantageous in that it aids the impecunious student to obtain advantages in education which are ordinarily only enjoyed by the rich.

5. That students thus trained make better citizens and more successful men than when not thus physically trained.

The Land Grant colleges of the United States—of the several States, rather—are the product of one of the grandest examples of statesmanlike legislation that the world has yet seen; one second in importance and fruitfulness to no act of legislation subsequent to the promulgation of the constitution of the United States. Like all great enterprises having for their purpose the benefit of the people by legislative enactment, this failed of complete success through the indifference, the folly, and the absolute stupidity of many of those public servants to whom its operation was intrusted; it has, nevertheless, produced incalculable good, both directly, in the foundation and partial support of technical education, and also partly, and very probably to a vastly greater extent, through its influence upon the States, inducing them to take up and carry on the work from the point at which the general government left it. It is largely to this legislation that the foundation of the now numerous State universities is due, and the organization of the systems of State education which now more or less completely cover the whole field from primary schools to universities in a large proportion of our States, illustrating the scheme of a complete system of State education to which reference was made and of which the outline was given in the earlier part of this discussion, and more satisfactorily than anywhere else outside of Germany.

The author of the Land Grant Bill, by which colleges of the useful arts were established in every State in the Union at the date of its passage, was Justin S. Morrill, then senator from Vermont, who introduced the bill in 1858, and secured its passage by a small majority, only to see it vetoed by James Buchanan, then President of the United States. But the statesmen who sought thus to perpetuate the strongest safeguard of the nation, the effective education of the people, lost none of their interest or enthusiasm, and persevered in their plan, bringing the bill before the next Congress and the next, and finally they had the satisfaction of seeing this measure become a law during the administration of Lincoln and in the midst of dark days of the war. "The genius of Lincoln rose to the occasion. With one hand he smote off the fetters of the slave; with the other he joined in a splendid effort to subjugate nature. On the second of July, 1862, while the announcement of emancipation was still on his desk, he signed the act of Congress donating public lands for the establishment of colleges of agriculture and the mechanic arts."

In most cases the States complied fully with the terms of the act; some of them more than completely. In the majority of the States the funds were invested in either State bonds or in a special bond made out for this particular purpose by the State and deposited in its treasury, and the returns were either the prescribed five per cent. or something more, in every case except that of the State of New York, which latter State never, until compelled by the courts, complied either in letter or in spirit with the law. Main and Indiana paid five per cent.; New Hampshire, Vermont, Pennsylvania, North and South Carolina, and Ohio paid six; the funds being paid into their treasuries. Massachusetts was the only State in which the fund was divided; most of the State legislatures deciding at once and unhesitatingly that it would be better to hold the fund undivided and to either give it to some existing institution which should comply with the provisions of the grant, or founding an institution, as Cornell University in the State of New York, in direct compliance with the terms of the law.

The following is a summary of the contributions made to the cause of "education of the people by the people for the people" from the earlier days of the republic:*

1. Lands by the township, under acts of 1787 and 1800, amounting to over one million acres, for the support of State universities.

2. A considerable but unascertained proportion of the money surplus of $28,000,000 distributed to the States in 1836 and never recalled.

3. A portion of the $3,500,000 constituting the share of education in the total proceeds of land sales under the percentage acts of 1841 and later.

4. A portion of the 3,500,000 acres accorded by different States to education out of the 9,500,000 acres given by Congress in 1841 for internal improvements.

5. Further important sums not definitely known, from the sale of over 50,000,000 acres of swamp lands disposed of under provisions of the act of 1850, from which source alone the University of California is said to have derived important aid.

6. Revenues in a number of States from the sale of saline lands, with appropriations thereof to the support of colleges of agriculture and the mechanic arts.

7. The more than $15,000,000 already derived from the lands accorded to States by the act of July 2, 1862, for the support of colleges and the mechanic arts; which grant has resulted not only in the establishment of many important technical institutions, but also at the same time in such strengthening of the State universities that some of them are thus early taking their places in the foreground of the great university field.

8. The appropriation by act of March 2, 1887, of $15,000 per annum to each State for experimental purposes in aid of scientific agriculture in the broadest sense of that term, a yet further incidental re-enforcement of the many State universities.†

9. The aggregate of over $20,000,000 appropriated for the support of the Military Academy at West Point and the Naval Academy at Annapolis.

10. The establishment, equipment, and support of

* Delivered at the Anniversary Meeting of the Franklin Institute. National Export Exposition, Philadelphia, October 7, 1899.

† R. H. T. in New Jersey Report, 1878, page 28.

‡ "De l'Organisation de l'Enseignement industriel et de l'Enseignement professionel."

§ Letter from Gen. Morin to Mr. James Forrest, Secretary of the British Institution of Civil Engineering.

* Race Education. Samuel Royce. New York, 1878

* Blackmar's Report, of 1890, to the Bureau of Education. Hoyt's Report, of 1892, to the Senate Committee on a National University. Thurston's "Technical Education in the United States," 1893.

† The State of New York, as stated in the message of the governor for 1892-3, taught in the public schools 1,073,093 children in the year 1892 and 772,426 were either educated in private schools or were not taught at all. The State expended in this work $21,134,516; which was $865,000 more than was paid out, on the same account, in 1891.

the Naval Observatory and the purely scientific bureaus of the government at Washington.

11. The large sums of money appropriated for the convenience and support of the Congressional and departmental libraries.

12. The hundreds of thousands expended in buildings for the scientific museums of the government, and the more than $3,000,000 a year so wisely granted for their support.

The following is the list of these schools, as above, together with the numbers of graduates reported for the last year given, as collated and published by our authority in this matter.*

Of the now famous special schools, our United States Military Academy was the first to take form, founded as it was in 1802; the Naval Academy was organized in 1845, and both have sustained a high reputation for the excellence of their curricula and the high scholarship of their graduates. The first of the independent schools privately endowed was the Rensselaer Polytechnic Institute at Troy, N. Y., and its success led to the organization of many other schools of engineering in the succeeding generation. The Lawrence Scientific School was attached to Harvard University in 1847; the Department of Civil Engineering, of the University of Michigan, was organized in 1852; the Sheffield Scientific School was organized at Yale University in 1847, though much earlier proposed. The Massachusetts Institute of Technology was founded in 1864; Dartmouth College organized its technical departments in 1851, and the Thayer School in 1867. The Worcester Polytechnic Institute took form in 1868 and the Columbia College School of Mines in 1863. Peter Cooper founded the Cooper Institute in 1854 as a mixed educational and trade school and especially for the benefit of artisans and others unable to attend regularly the common and technical schools of regular curricula. The Stevens Institute of Technology was organized as the first American school distinctively and especially devoted to the professional training of mechanical engineers and for the first time recognized that branch of engineering as a profession. The Towne Scientific School of the University of Pennsylvania and the technical schools and colleges of Cornell University were organized in 1868, and about 1885 the latter became recognized as colleges under the university organization. Since 1870, there have been almost annually organized and endowed schools of manual training, trade schools, and polytechnic and professional engineering schools until, to-day, every great city is provided with one or more. Philadelphia and Chicago are peculiarly fortunate in this respect. Nearly every large college or university has nominally if not actually professional and technical schools incorporated into its organization and the majority are doing admirable work in these directions. There are, to-day, about one hundred reputable technical and engineering schools in the United States and they annually graduate about 1,000 students into the constructive professions.

The Franklin Institute, of the State of Pennsylvania, in its work of promotion of the mechanic arts, has taken no small part in the development of these modern systems of evolution of the Miltonian idea. During the seventy-five years which have, to date, measured its period of useful life it has performed an enormous amount of helpful work in a variety of ways.† Its endeavors have always been effective in the union of science with practice; its membership has always included men of science and men of business, educators and philosophers and great mechanics; its work has always been carried on in fields of applied science with every apparatus of instruction—schools, lectures, systems of research, exhibitions of invention and construction, and all methods of promotion of technical training of young and old, learned and unlearned. The names of Ronaldson, Merrick, Cresson, Rogers, the Merricks and the Sellers, of Bache and Morton and Wilson, Tatum, Heyl, and Sartain, of Jones and Longstreth and Norris and Trautwine and Houston, and many others familiar to the world, have adorned a catalogue of officers and members such as perhaps can hardly be paralleled in any other State or in any other country.

The institute has established and has carried on for all these decades technical lectures, drawing schools, even a high school for a time; it has gathered together a very extensive, unique and valuable technical free library and has published scientific and practical treatises, either officially or indirectly; it has published for now over seventy years its Journal of the Franklin Institute, complete files of which have been probably more extensively and for a longer time maintained in the libraries and technical institutions of this country and of Europe than have been those of any other existing publication of its sort on either side of the Atlantic. It has even longer maintained a Committee on Science and the Arts empowered to examine and report on inventions and advances in the mechanic arts and applied sciences. The files of the journal are rich in contributions of useful and extensively important matter from this committee. Medals and premiums have been offered and awarded for great inventions and improvements in the arts and in mechanisms, and the careful investigation of claims and the selection of worthy objects of such honors by the representatives of the institute has been of immense assistance in the promotion of the highest material interests of our country. These gratuitous services have never been and can never be adequately appreciated or recognized. These committees and the journal have always been the subject of careful surveillance by the best men of city and State. The editorship of the journal has illustrated this fact, for its list consists of the names of Alexander Dallas Bache, C. B. Trego, Profs. Frazer, Henry Morton, and George F. Barker, Robert Briggs, and two periods of service are assigned to Dr. Wm. H. Wahl, the present secretary and editor. The committee on publication, always supervising the work with conscientious care, has consisted, also, of the best men in the membership of the institute. It may well be doubted if any technical journal in the world has a richer list of technical contributions.

The great Exhibition of American Manufactures of 1824 and its successors have had an immense influence in the improvement of all the arts and manufactures of our country. In that of 1874 more than 200 silver and over 220 bronze medals and 650 diplomas were awarded to as many deserving products of American invention and skill. The electrical exhibition of 1884 probably did more to show what were the prospects of the then infant industry than any other incident or influence of the time. It was the first of its kind and gave a prodigious impetus to that vocation and those many industries which are to-day grouped within the special field of electrical engineering. The greatest men of science, the most famous mechanics and the ablest manufacturers of mechanism found there attractions and impressive novelties that had hitherto been to them almost undreamed of. A National Conference of Electricians, then necessarily mainly composed of physicists—for this branch of mechanical engineering had not then taken form as a department of construction or a division of the profession of engineering—and the exhibition and this congress together laid the foundations of the vast structure now constituting such an imposing division of our industrial system.

Researches like those described in the report of the committee organized to investigate the theory and practice of hydraulic motor construction, in the report on steam boiler explosions, still an engineer's classic, and in that of the committee investigating the strength of the materials of construction were at once useful and impressive. A weather bureau, even, was organized in 1843 and the later State weather service and that of the United States may be fairly claimed to have grown out of that first work of this kind. The now universal system of standard screw threads was the product of the studies of another committee, and the later investigations of water supply for the city of Philadelphia, of the efficiencies of dynamo-electric machines and of the duration and efficiency of electric lamps have continued the early established practice of the institute into our own time.

All this enormous amount of work in the promotion of the useful arts and applied sciences has been the voluntary service of able men and not a dollar has been expended for their precious and invaluable time and thought and labor. It may well be doubted whether the history of any country or of any institution gives nobler exemplification of true patriotism.

The work of this now famous institution has not been simply, however, in the departments which have been mentioned; it has done a great work in aiding other enterprises. For a century and more, this country, following the lead of its great statesmen of the days of the revolution and of the early period of our existence as a nation, adopting the principles so admirably expressed by Hamilton and sustained by Washington, Jefferson, and all their immediate successors, has made the promotion of the industrial arts a primary business in legislation and through executive action. This policy has borne fruit in the institution of a remarkably effective system of patent law, in the organization of all the essential manufacturing industries and in the advancement of agriculture, directly and indirectly; supplying a home market for its products and giving it machinery which harvests its grain at ten times the rate usual seventy-five years ago; which transports it a thousand miles at less cost to the owner than then it could be sent a day's journey to market and opens the most distant lands of the trans-Mississippi region to settlement by the sons of the original thirteen States. In this work the Franklin Institute has taken part, and in no manner more effectively than in the inauguration of exhibitions of the products of industry, in the assistance in many ways of the managers of the great International Exhibition of 1876, in the promotion, jointly with the Philadelphia Commercial Museum, of the great Philadelphia Exposition of 1899.

The outcome of the policy of Hamilton has been the successful construction of a great system of domestic industries which, now that it has reached its period of maturity, is not only capable of supplying to our own people the cheapest products, the best products, and the most abundant; but it is at the same time making compensation to its working people in the highest wages paid in the world; thus giving them the means of buying more of the comforts and luxuries of modern life than any other people, while extending the market for the product of each industry and of each producer by making it possible for the members of every craft, and for every individual earning wages, to buy of every other producer. The fact that it is mainly by the payment of high wages to the wage earner that a market can be made for every product at best advantage has never before in the history of the world been so well illustrated. In this great work of promotion of the whole system of American industries, Pennsylvania, and especially Philadelphia, and particularly the Franklin Institute, has had efficient part, and the possibility of that most astounding novelty—to the disciples of Cobden and to the practitioners of the Hamiltonian method as well—has arisen from this most successful and well sustained work of the nineteenth century in our country. An "Export Exposition" in the United States, at the end of a century of, on the whole, steady and consistent support of the policy of upbuilding and maintenance of home industries, is a lesson to the world and one which economists of the antique sort may well study with profit. Free institutions, the patent system, the protection of domestic trade and manufactures, the consequent growth of the industrial arts, and of manufactures, the resultant provision of a market for the agriculturist, the marvelous stimulation of invention, the growth of a people in intelligence, ambition, productivity, and prosperity, which have all come of the enlightened policy of the founders of the nation, are admirably illustrated at this great exposition, the crowning glory of the Franklin Institute and of the merchants of Philadelphia, and may well astonish the world.

Thus the "Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts" continues, after seventy-five years of good works, to do its noble duty more effectively each year. May the work so well begun in our century continue with increasing efficiency for many centuries!

* Engineering News, March 26, 1892.

† For a detailed account of its work, see "A Sketch of its Organization and History," by Dr. Wm. H. Wahl, Secretary of the Institute; published by the Institute, 1895.

ABUTILON VITIFOLIUM.

IN the spring of the year Mr. Hartland, of Cork, sent us, says The Gardeners' Chronicle, as has been his wont in former years, specimens of this beautiful shrub. It is a native of Chile, but is hardy enough in the southwest of Ireland, as it forms a bush 30 feet in height and 25 feet in diameter. The whole plant is covered with soft velvety down, as is the case with so many of the Malvaceæ, and the leaves are deeply and sharply lobed, whence the specific name. The flowers are lavender blue, very freely produced, as our illustration shows; so that the shrub is one of the most desirable for sheltered localities in the western and southern counties. We have no experience of it near London.

ABUTILON VITIFOLIUM—FLOWERS LAVENDER-BLUE, ANTHERS YELLOW.

OLDEST POEM IN THE WORLD.

NEAR to the pyramid at Illahun, Prof. Petrie found during his explorations in 1888–1890 the extensive town occupied by the workmen employed by Usertesen II. in building his pyramid and other public works. In the office where the records of the town were kept, Prof. Petrie discovered a large number of papyri. Most of these were official and legal documents, relating to the works carried on, accounts of payments to workmen, of food and provisions received and issued, fiscal accounts, census papers, etc., and all the usual accumulation of a government office—dry and uninteresting on the whole, but abounding in details which are of the greatest value to the historian and archæologist. The more attractive fields of general and scientific literature were not, however, unrepresented, for we have works on medicine, diseases of women, veterinary surgery, and mathematics; but the gem of the collection is a royal ode, or hymn of welcome addressed to Usertesen III., apparently by the people of the Fayoum.

After long and patient work, these broken and torn fragments have been arranged, and are now published with autotype reproductions, transcripts and partial translations by Mr. F. Llewellyn Griffith. The poem to Usertesen III. is written in a fine, bold, hieratic hand upon a papyrus measuring 46 inches in length and 12 inches in width, and consisted, when complete, of six stanzas of ten lines each. Its value lies in its being certainly the oldest poem in the world, nearly fifteen centuries before the time of Moses; and also in the wonderful way in which it describes, in most figur-

ative language, the great work that the king had done in the expansion of the Egyptian empire.

Homage to thee our Horus divine of beings,
Protecting the land, and widening its boundaries,
Enclosing the two lands, within the compass of his hands, and seizing the nations in his grasp.
The tongue of his Majesty bindeth Nubia, his utterances put to flight the Bedouin.
Sole one of youthful vigor guarding his frontier; suffering not his subjects to faint; but causing all the people to repose unto daylight.
As to his trained youth, in their slumbers, his heart (mind) is their protection.
His decrees have formed his boundaries; his word maketh strong the two regions.

Twice joyful are the gods; thou hast established their offerings.
Twice joyful are thy forefathers; thou hast increased their portions.
Twice joyful is Egypt in thy strong arm; thou hast protected the ancient regime.
Twice joyful are the people in thy policy; thy mighty spirit hath taken upon itself their welfare.
Twice joyful are thy paid young troops; thou hast made them to prosper.
Twice joyful are thy veterans; thou hast made them to renew their youth.

Twice great is the lord of his city; he is as it were a dike damming the stream in its water floods.
Twice great is the lord of his city; he is as it were a cool shelter, letting every man repose unto daylight.
Twice great is the lord of his city; he is as it were an asylum; delivering the frightened one from his enemy.
Twice great is the lord of his city; he is as it were a verdant shade and cool place in the time of harvest.
Twice great is the lord of his city; he is as it were a corner warm and dry in time of winter.
Twice great is the lord in his city; he is as it were a rock barring the blast in time of tempest.

The closing lines are:

He hath come; he hath made the people of Egypt to live; he hath destroyed its afflictions.
He hath come; he hath made men and women to live; and hath opened the throat (voice ?) of the captives.
He hath come; we nurture one; we bury our aged ones (in peace).

TIDES OF CHESAPEAKE BAY.

A SUCCESSFUL attempt to fix a permanent tidal plane for the Chesapeake Bay has recently been made by the United States Coast and Geodetic Survey, says E. D. Preston, United States Coast and Geodetic Survey, in The National Geographic Magazine. During the last fiscal yearly 40 stations were occupied, at 13 of which we are in possession of simultaneous tidal observations extending over one complete lunation.

The application of harmonic analysis to this unique series along our seaboard will open the way for correct predictions from the Capes to Havre de Grace, and will also result in the establishment for the whole bay of a plane of reference of unequaled permanence and undoubted accuracy. The establishment of an invariable datum plane is one of the first requisities of inshore hydrography. The accuracy with which such reference level should be determined depends, of course, on the nature of the work based upon it. In foreign surveys vast sums have been expended in maintaining tide-measuring instruments in the North Sea, along the coast of France, and in the Mediterranean Sea. These have been connected, wherever possible, in efforts to compare the sea-level at different ports around Europe. France and Spain occupy favorable positions in work of this kind, since by comparatively short lines, without leaving their own territory, they may connect the mean sea-levels of the Atlantic and the inland waters east of Gibraltar. How important the determination of heights is regarded abroad may be judged from the fact that up to 1895, the date of the last published report of the International Geodetic Association, more than 122,000 kilometers of precise leveling had been done in Continental Europe, and nearly 99,000 permanent bench-marks had been established. This work has had its greatest development in Germany, Austria, and France, in the order named.

The average tide for the entire bay is about one foot; possibly less. For Old Point Comfort we have 2½ feet; for the mouth of the Potomac, 1 foot; for Washington, 3 feet; Richmond, 3 feet; Elk River, at the head of the bay, 2 feet, and Annapolis less than 1 foot. The wind effect, however, is sometimes more than the total tide. For example, at Baltimore the wind effect may amount to 3 feet, while the tide proper uninfluenced by local disturbances, is only one-third as much. This diminution in the height of the tides as we come northward from the entrance and the subsequent increase as we continue on in the same direction is one of the peculiar features of the tidal phenomena of the bay.

The small range at Annapolis is due partly to the change in width of the bay, but principally to the fact that there is an interference at this point between the incoming and outgoing tidal waves. When the crest of the southbound movement reaches the mouth of the Severn River it meets the northbound waves from the Capes, and a partial neutralization of the vertical motion of the water takes place. Another interesting point in connection with the subject is that the rate of progress of the tidal wave from the mouth of the Potomac to Washington is somewhat less than that of an ordinary steamer, so that a vessel requiring the greatest depth possible would be able to enjoy the condition of high water during its entire passage up the river. The fact was first brought out by Mr. C. A. Schott many years ago, when the "Great Eastern," of transatlantic cable fame, availed itself of this favorable circumstance and came to anchor within a few miles of the Capitol.

Transparent Photographs.—The following mixture may be employed at 80° C. to render photographs transparent. It consists of 4 parts paraffine and 1 part linseed oil. After the immersion the photos. are at once dried between blotting paper. For fastening these photographs to glass, glue or gelatine solution alone can no longer be employed. This only becomes possible, according to Stockmaier, when one-fourth of its weight of sugar has been added to the glue before dissolving. The glasses for applying the photos. must be perfectly flawless, because the slightest defects become visible afterward.—Drogisten Zeitung.

Duty on Collodion in the Netherlands.—Minister Newel writes from The Hague, August 22, 1899, that, according to a royal order appearing in the Official Gazette of even date, it is decreed that, subject to certain regulations as to quantity admitted, destination, etc., so as to guard against abuse of the privilege, collodion required in the preparation of incandescent light mantles shall be exempted from import dues.

THE

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